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THE BALTIMORE ELECTRICAL COMMISSION has submitted its report to the Mayor favoring the construction of a system of electrical subways to be owned by the city and rented to the various electrical companies. The report is a most elaborate one and reflects great credit upon the commission and its engineer, Mr. Nicholas S. Hill, Jr. We shall review it at greater length in an early issue. Coincident with the appearance of this report is the decision of the Maryland Court of Appeals denying the suit of the Baltimore Edison Co., which claimed that it had a right to build electrical subways without a franchise from the city. As the people at the last election voted in favor of the construction of an electrical subway system by the city, the decision is an important one.

MUNICIPAL OWNERSHIP OF ELECTRICAL subways in Erie, Pa., has been recommended by a committee of the Select Council and the recommendation has been adopted. The system is yet to be constructed.

MUNICIPAL OWNERSHIP OF WATER-WORKS, at Des Moines, Ia., has been in contemplation for some time. The city recently offered the Des Moines Water-Works Co. $800,000 for its plant. The offer not having been accepted the city council has instructed Mr. L. Higgins, City Engineer, and the Board of Public Works to submit plans and specifications for a new plant. Authority to engage an engineer to assist in the work has been given.

MUNICIPAL OWNERSHIP OF STREET RAILWAYS is in force at Dover, England, and that city is now advertising for bids for the material and construction of three miles of line. The work will be under the supervision of the Borough Engineer.

COMPRESSED AIR MOTOR CARS on the Hoadley system (as now being tried by the Metropolitan Traction Co., of New York city) are to be manufactured by the Compressed Air Power Co., which has recently been incorporated. Joseph H. Hoadley is president; A. H. Paget, secretary, and Wm. C. Whitney and W. L. Elkins, of the Metropolitan Traction Co., are among the directors.

THE TRANSMISSION OF ELECTRIC POWER from Niagara Falls to Buffalo was celebrated on Jan. 12, by a banquet at the Ellicott Club, in Buffalo, attended by about 400 persons. The assemblage was remarkable for the number of prominent electricians, inventors and manufacturers present. Among these were Nikola Tesla, Elihu Thomson, E. G. Houston, Charles F. Brush, Elisha Gray, Charles A. Coffin, George Westinghouse, John E. Hudson, D. O. Mills, Dr. Coleman Sellers, Francis Lynde Stetson and Dr. Louis Duncan.

ELECTRICAL MINING MACHINES are coming into extensive use in Ohio, and are displacing compressed air machines, according to the report of the State Inspector of Mines for the year 1895, recently issued. In that year 82 air and 82 electrical machines were in use, while in 1894 the air machines were 112 and the electric machines 50. The total amount of coal mined in the state in 1895 was 13,683,879 tons, of which 3,120,456 tons were mined by machinery, a gain over 1894 of 564,990 tons.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head collision of freight trains, Jan. 9, on the Atchison, Topeka & Santa Fe Ry., near Fort Worth, Tex. Two men were killed.

SEVERAL BOILER EXPLOSIONS are reported: A sawmill boiler exploded Jan. 4 at Hazlehurst, near Bradford, Pa., killing one man and injuring four others.——The boiler of a steam chopper operated by farm hands, near McKeesport, Pa., exploded recently, and set fire to a barn containing grain and farm implements.——Two of the four boilers at the State Asylum for the Insane, at Medical Lake, Wash., exploded Dec. 29, killing one man.——A boiler at the Peerless Rubber Works, New Durham, N. J., exploded Jan. 9, fatally injuring one man.——A boiler at a drilling plant of the Fisher Oil Co., near Sistersville, W. Va., exploded Jan. 6, killing two men and injuring two more.

A JOINT RESPONSIBILITY FOR ACCIDENTS has been decided by the U. S. circuit court in a case for damages arising from the crossing collision near Atlantic City, N. J. (Eng. News, Aug. 6, 1896), between trains of the West Jersey R. R. and the Philadelphia & Reading R. R. The suit was brought against the former, and the company claimed that it had no responsibility. The court held that suit might be brought against either company.

THE APPLICATION OF SAFETY APPLIANCES to railway cars is likely to be delayed somewhat, as representatives of many of the large railways have asked the Interstate Commerce Commission to recommend to Congress an extension of the time for the equipment of all cars. The time set by the present law is Jan. 1, 1898, but an extension of two to five years is proposed. It is said that in view of the financial situation of many of the railway companies, the commission is likely to favor the extension.

A RAILWAY EMPLOYEES PENSION BILL is to be introduced in the New York State legislature. It will provide that whenever any employee of a steam railway company shall become wholly or partly disabled while in the discharge of his duty, the company shall provide for his support by assessing its dividends not exceeding 1% per year. While an employee is disabled he is to get half pay as long as incapable. If he is killed, the company is to give the widow 50% of his salary. If a disability is only partial and the road offers a man other employment, he must accept. The act is not to be effective against any corporation until a majority of employees of the company certify that they desire it.

A UNION STATION at Albany, N. Y., is proposed, and plans have been prepared at the instance of a city committee. The station would provide accommodation for the New York Central R. R., West Shore R. R., and Delaware & Hudson R. R. The cost is estimated at $500,000 to $750,000. The building would occupy practically the same site as the present New York Central R. R. station, including also that of the old Delavan Hotel, which was burned some years ago.

A STATE RAILWAY COMMISSION for New Jersey is recommended by Governor Griggs, of that state. One of its most important duties would be in regard to the abolition of the numerous grade crossings.

LOCOMOTIVE CONSTRUCTION IN GREAT BRITAIN was more active during the past year than it has been for some years formerly, and we take from the "Engineer," of London, the following table of the number of engines built by the leading firms during the past five years:

| | 1892. | 1893. | 1894. | 1895. | 1896. |
|---|---|---|---|---|---|
| Neilson & Co. ..... | 2,307 | 1,896 | 1,510 | 1,617 | 2,360 |
| Dubs & Co. ..... | 1,697 | 1,775 | 1,465 | 1,773 | 1,868 |
| Beyer, Peacock & Co... | 1,292 | 1,350 | 1,239 | 1,196 | 1,727 |
| Sharp, Stewart & Co... | 1,507 | 1,246 | 1,145 | 1,178 | 1,333 |
| Kitson & Co. ..... | 1,268 | 1,079 | 1,143 | 915 | 1,192 |
| Vulcan Foundry Co... | 561 | 486 | 610 | 514 | 770 |
| R. Stephenson & Co... | 455 | 344 | 320 | 387 | 586 |
| Nasmyth, Wilson & Co. | 377 | 320 | 340 | 337 | 450 |
| Manning, Wardle & Co. | 207 | 203 | 226 | 314 | 370 |
| Hunslet Engine Co. .. | 240 | 245 | 234 | 242 | 245 |
| | 9,971 | 9,043 | 8,251 | 8,473 | 10,910 |

WATER FILTERS FOR THE PUBLIC SCHOOLS of Chicago are a subject of contention in that city. Health Commissioner Kerr recently notified the Board of Education that on Jan. 11 water would be shut off at all schools where filters had not been provided. The idea seems to be that many of the children are provided with pure water at home, filtered or bottled, and should be protected at school. Throughout the past year the city water from some of the intakes has often been pronounced dangerous, and within the past few days a heavy rain has swept much polluting matter from the Chicago River into the lake. The Waukesha Water Co., which supplied water at the Columbian Exposition, is reported to have made a proposition to supply the schools. It laid a pipe line from a point near Waukesha to Chicago, some 90 miles, but, being prevented by Waukesha from piping spring water out of that town, it secured water from a point not far distant. The company is now reported as renewing its efforts to get a franchise from the Waukesha council permitting it to lay pipes to connect with its line outside the city.

NEEDED EXTENSIONS TO THE WATER SUPPLY of Brooklyn seem to proceed slowly, according to statements in a report by Mr. J. M. De Varona, M. Am. Soc. C. E., engineer of the water supply, to Mr. Peter Milne, Chief Engineer of the Department of City Works. In January, 1897, Mr. Varona pointed out that steps should be taken to make available within five years an entirely new source of supply, besides those then under development on Long Island. This supply might be obtained further to the eastward on Long Island, or from sources off the island. Mr. De Varona now states that not only have no definite steps towards a new supply been taken, but the completion of work under way or contemplated at the time of the report to make fully available the present drainage areas has been retarded. He urges that steps be at once taken to select a new source of supply, to be made available by the close of the present century.

THE PNEUMATIC MAIL TUBE, between the general post offices of New York and Brooklyn, has now been decided upon, and the Post Office Department has awarded the contract for a line of tubes, 8 ins. inside diameter, to the United States Mail Package & General Pneumatic Delivery Co., of Philadelphia, Pa., of which Mr. Wm. J. Kelly is president. The transportation contract is for four years, at $14,000 per year.

THE OHIO RIVER SUSPENSION BRIDGE, between Rochester, Pa., and Monaca, has recently been completed. It is 2,200 ft. long, has a channel span of 800 ft. and a headway of 90 ft. for this span. It was designed by E. K. Morse, of Pittsburg, Pa. The masonry was built by W. C. Jutte and the superstructure by the White Bridge Co. The cost was about $175,000.

THE INVESTIGATION INTO THE CONDITION OF the steel plates furnished for the holds of the battle-ships "Kearsarge" and "Kentucky" has resulted in a report to the effect that the steel was satisfactory when tested longitudinally or in direction of the length of the plate, but not when tested laterally or crosswise, and the Acting Secretary of the Navy has directed that the constructor at Newport News may use as much of the material as proves satisfactory, considering the place which it is to occupy in the ship's hull, each plate to stand or fall by an individual test. The cause of the defects in the plates is found, in the opinion of the special board of investigation, to be the fact that the plates received more work in rolling in the direction of their length than across it, and the failure to detect the defect is due to the fact that the specifications do not require bending specimens to be cut crosswise of the plate. The board is of the opinion that more reliable steel for hull plates would be obtained if the tensile strength required from the plates was made to vary between 57,000 and 66,000 lbs. per sq. in., the required elongation of the steel running above 60,000 lbs. tensile strength to be not less than 25%, and for steel below 60,000 lbs. this required elongation to be increased one-third of 1% for each 1,000 lbs. below 60,000 lbs.

Mr. Hichborn, Chief of the Bureau of Construction, in forwarding the report of the board, says in relation to the quality of the plates furnished:

An examination of the sheet giving the results of tests submitted by the board shows that as regards tensile strength and elongation the metal complies very well with the specifications, the average tensile strength being in the neighborhood of 65,000 lbs., and but two specimens taken from the same plate falling appreciably below the elongation required of 25%. The variations in tensile strength between the elongation and transverse specimens are slight and irregular. The average elongation of the longitudinal specimens is 27.7%, and that of the transverse specimens 26.2%.

The failures which occurred were in the cold bending and quenching tests, and it is only under these tests that with the material in question there appears to be any marked difference in the behavior of the transverse and longitudinal specimens—the transverse specimens, as might be expected, showing greater tendency to brittleness.

THE NAVAL STEEL BOARD, which has had charge of the inspection of the steel furnished for all the new naval construction, has, as a result of the investigation referred to above, been reorganized in accordance with the recommendation of the board of investigation, so that its control will be in the hands of officers of the construction and engineering departments, instead of officers of the line. Naval Constructor R. B. Dashiell has succeeded Lieut. Commander Everett, and Capt. Day, the president of the board, has been replaced by Capt. Geo. W. Coffin. The young officers of the line who have heretofore done the work of inspection at the steel mills will also be replaced by civilian inspectors, appointed at a per diem compensation. Passed Assistant Engineer Freeman continues to be a member of the board. The new board will at once take up the work of revising the specifications for steel.

## SPECIAL TOOLS USED IN THE CONSTRUCTION OF THE NEW U. S. LOCK AT SAULT STE. MARIE, MICH.

The successful design of a special small tool or machine to perform the frequently occurring but individually small operations that pertain to every large piece of contract work often makes an important difference in the debit and credit columns of the contractor's ledger. As an instance of this may be mentioned the modified draw knife designed by a cooper "in hard luck," who had obtained employment as a mucker on the St. Clair Tunnel work, and who, unused to the spade, adopted the tool most familiar to his hands with the result of causing the engineers to so equip his companions and thereby materially increase the rapidity of excavation. It is probable that every old contractor can call similar instances to mind. As one contractor was recently heard to say: "it is whittling off the edges that eats up profits," and the contractor who can design a device for doing this whittling cheaply is often able thereby to reduce materially the cost of his work and correspondingly increase his profits. Among the numerous cases of this kind, the construction of the great 800-ft. Poe Lock, at Sault Ste. Marie, Mich., is an interesting one, and in a visit to this work by one of the editors of this journal the accompanying sketch view was obtained, which shows quite clearly a number of these small labor saving devices in actual operation.

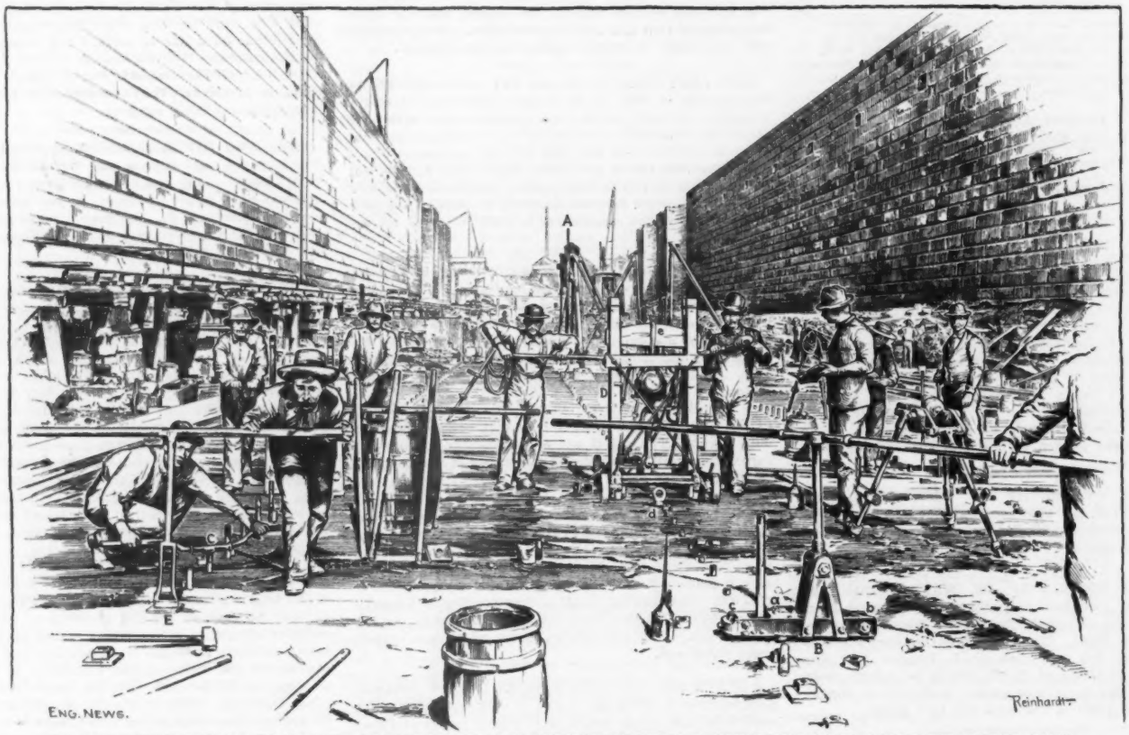
To construct the culverts and lock floor for the Poe Lock, the bottom of the lock pit was thoroughly cleared of broken stone and dirt, and then a thin coating of mortar was spread on the foundation rock. The surface was then brought to a level by a layer of concrete. On this concrete longitudinal timbers 12×12 ins. were first laid about 10 ins. apart, and bolted to the foundation rock with 1½-in. bolts, spaced 3 ft. apart and extending at least 3 ft. into the rock. Each of these bolts was required to resist a test pull of 10 tons. On top of these longitudinals, transverse timbers 12×12 ins. were laid 6 ins. apart and drift-bolted to the longitudinals, and also bolted to the rock. These transverse timbers were covered with a flooring of 3-in. plank after all interstices had been filled with concrete. It was to accomplish this floor work that the special tools illustrated were devised, the illustration in fact showing the floor work in progress.

After preparing the foundation bed the first work was the placing and bolting to the rock of the 12×12-in. timbers. For this, holes had to be drilled into the rock and partially green concrete for the holding down bolts, and here the first difficulty that arose was the wedging of the drill in the green concrete. The difficulty was successfully overcome by means of the apparatus shown at A in the engraving. This consisted of a small pile driver frame on which an ordinary compressed air drill provided with guides was hung between the ways just as the hammer would ordinarily be hung. A wire rope was attached to the top of the drill and passing over a sheave at the top continued to and around a drum or windlass attached to the rear braces of the frame. By turning the drum the drill was raised and lowered in a manner easily understood, and moreover it had such a long range of vertical movement that a very deep or a very shallow hole could be drilled without change of drills, a thing not possible with the ordinary tripod arrangement. To prevent wedging, the bit of the drill had an unusually wide flare or splay which permitted a small copper pipe to be inserted nearly to the bottom of the hole between the rock and the drill shaft. By forcing water through this pipe under heavy pressure the chips were carried away before they could wedge the drill. This extremely simple device enabled its inventor, a sub-contractor, to drill at a profit on the contract price of 25 cts. a ft. after another contractor, working with the ordinary air drills, had abandoned the work on account of the cost being above the contract price.

The bolts being set in place, foxtailed and grouted, the next step was to cut off the unnecessary projection above the timber and this was done by the apparatus shown at B, in the engraving. In this apparatus the vertical screw raises and lowers a toggle, one arm of which is hinged at a and the other arm of which is hinged to a cross-head b, sliding horizontally in the guide frame a c. The cross head carries a shear or chisel edge, facing the bolt, and at c there is a corresponding shear also facing the bolt. By forcing down the toggle the cross-head is forced toward c, and the two shear blades cut off the bolt.

The next move was to thread the bolt ends, and the apparatus for doing this is clearly shown at C, in the engraving. After threading the holding-down power of the bolts was tested by the apparatus shown at D. The eye nut d being screwed onto the bolt the apparatus was placed vertically over it, and the nut attached by means of a clevis and rod to the cross head e, whose opposite ends rested on the plungers of two hydraulic jacks. Lifting the cross-head by means of the jacks brought a pull on the bolt, whose amount was recorded by the attached pressure gage, and, as already stated, this test pull was 10 tons. In case the bolt withstood the test the washer and nut were then screwed on, as clearly shown at F in the illustration. At F, the boring machine for boring the bolt holes in the 12×12-in. timbers is rather indistinctly shown, but as it was an ordinary machine of this kind no further illustration is necessary.

It will be seen from the foregoing that all of these devices, excepting a few special parts, such as the pressure gage, air drill head, threading dies, etc., were such as could be made by any blacksmith of ordinary skill, and were cheaply constructed. They, however, served admirably their purpose, and their illustration is an example of a phase of contractor's work which is too often lost sight of, but which often make it possible for one contractor to accumulate a fortune at works where another contractor will lose one.




VIEW SHOWING SPECIAL TOOLS USED IN CONSTRUCTING FLOOR FOR 800-FT. U. S. SHIP CANAL LOCK, SAULT STE. MARIE, MICH.

## ELEVATION OF THE NEW YORK, NEW HAVEN & HARTFORD R. R. AT BOSTON, MASS.

(With two-page engraving.)

The New York, New Haven & Hartford R. R. has during the last few years spent immense sums of money in the improvement of its road by four-tracking and by changing the grade at various points to eliminate numerous street crossings at grade. A costly piece of work of this latter kind is the elevation of the line for a distance of about 4½ miles near Boston, and this work, which is now well advanced, was recently inspected by a member of the staff of this journal. It includes the construction of bridges and stations, the laying of sewers and water mains, the elevation of freight yards, and other incidental work. The cost will be about $3,500,000, which will be paid by the state, city and railway company, in accordance with the grade-crossing law of Massachusetts. The city and state together will pay

45%, leaving 55% to be paid by the railway company.

A plan and profile of this improvement are shown in Fig. 1. At Cumberland St., not far from the Park Square terminal station, the new line commences to rise by a grade of 0.4%, increasing to 0.8% for a short distance, this being the maximum grade. When the elevation of 20 ft. above the old (and street) grade has been attained, giving a headway of 14 to 15 ft. for the cross streets, the maximum grade is 0.68%, and the average grade only 0.1%. This new elevation continues to a point beyond Forest Hills and the junction of the West Roxbury branch, where it runs down to the old level by a grade of 0.57%. There are no changes in alinement. The line will have four tracks throughout, while near the Boston end there will be six tracks, and at two of the five stations the freight yards have to be raised to the new grade. New water and gas mains and new sewers have had to be built on some of the cross streets, this work being done at the expense of the railway company. Four streets have been lowered from 2 to 5 ft., and one street was lowered to 17 ft. below the original grade, in order to give the necessary headway. In this last case, street approach grades of 4.6% were used.

The new line is on an earth embankment between heavy masonry retaining walls, and is carried across the streets by masonry or iron bridges. The normal elevation is 20 ft. above the old grade. The masonry work is done under two contracts, by John J. O'Brien and H. H. Brown, both of New York, and this work aggregates about 140,000 to 150,000 cu. yds., including the retaining walls and the arches. The filling is done by the railway company.

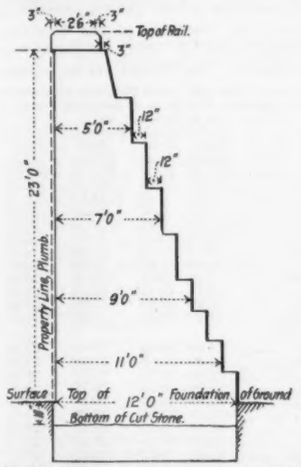



**Fig. 2.—Standard Cross-Section of Retaining Wall.**

The masonry is all of rock-faced granite from Quincy, Fitchburg and Maine, the face work of large rock-faced blocks in random ashlar courses. Fig. 2 shows the standard design of retaining wall, and Fig. 3 shows the actual construction, with rough blocks of massive size for the backing. Fig. 6 shows the general appearance of the work, which is very pleasing and effective. Fig. 4 is a view of the handsome five-arch viaduct at Forest Hills, this structure having been demanded by the local authorities as the line here crosses a broad and handsome avenue leading to the park. The design is bold and simple, but highly satisfactory.

The stone for the retaining walls and arches is delivered on the work at the rate of from 40 to 80 cars per day, with 12 cu. yds. per car. Two stone trains arrive every day, and during the night the cars are switched to make up a train with a certain amount of face stone and backing stone for each of the 30 or 40 derricks on the work to be supplied. Early in the morning the train is run down the service track on the old grade, behind the line of the wall (as shown in Fig. 3) and the proper number of cars are cut off at each derrick. At 5 p. m. the empty cars are hauled out. Work is carried on day and night, but no masonry is allowed to be laid at night, the derricks then being used for excavation or general work. A number of masonry inspectors are employed, one to each derrick, or each group of derricks. These inspectors submit daily reports of the work at each derrick on printed cards 6⅝ × 3⅝ ins., of the form shown below. The report states the kind of work (wall, arch, etc.), the number of men of each class of labor employed, whether the work is done by the company or the contractor, time of starting and stopping work, and the approximate number of cubic yards of work done. If the progress of the work is likely to be delayed by lack of men or materials, the inspector makes note of this on the card, stating what is wanted to expedite the progress, and the engineer in charge sees that this is attended to.

**OFFICE OF ASST. ENGINEER OF CONSTRUCTION.**
N. Y., N. H. & H. R. R., OLD COLONY SYSTEM.
JAMAICA PLAIN, MASS.

*Inspector's Report,* ..... *189*

Kind of Work .....

Location .....

Men employed by { Contractor / Company } Started Work at ..... Stopped at .....

If work stopped out of hours, give cause .....

| FORCE ACCT. | Foreman | Mason | Carpenters | Single Teams | Engineers |
|---|---|---|---|---|---|
| | Laborers | Helpers | Helpers | Double Teams | |

Approximate Amt. of Work done .....

If lack of men or materials is likely to cause delay, state what is required .....

(Signed,) ..... Inspector.

To be returned to office at end of each day.

NOTE.—Full report of any accident must be made to this office at once in writing. Also report delays to train service from whatever cause, stating train, time, etc.

Per order C. M. INGERSOLL, Jr., Asst. Engr. Const.

**FORM OF INSPECTOR'S REPORT USED ON THE TRACK ELEVATION WORK AT BOSTON, MASS.**

The cement used is tested daily, samples being taken from every fifth or tenth barrel. Cement which passes the tests is conspicuously marked, and no barrels are allowed to be sent out onto the work unless thus marked, all rejected cement being immediately removed. Masonry work was carried on all through the winter of 1895-96, the materials for mortar being heated and salt water used for mixing. No signs of defect in this masonry have been discovered.

By this new work 12 grade crossings have been eliminated, one street over the railway has been lowered to pass under the railway, and seven new streets have been opened under the railway. There are 20 bridges in all, besides 5 new masonry subways and 2 masonry arches lengthened for additional tracks. Of the bridges, 13 are of plate girder construction, 2 are steel arches of 50 ft. spans, and 5 are masonry bridges. The plate-girder bridges have the Dawley & Francis solid trough flooring, which is used so extensively on this road. They are half-through bridges, with single-web girders on the outside, and double-web box girders between the tracks, the flooring being carried on shelf angle-irons about 12 ins. above the bottom chords. The troughs are filled with clean pebbles, over which tar is poured, and above this is the broken stone ballast, the track being above the level of the top chords. These bridges were built by the Pennsylvania Steel Co., of Steelton, Pa.; the Pencoyd Iron Works, of Philadelphia, Pa., the Boston Bridge Works, of Boston, Mass., and the Berlin Iron Bridge Co., of East Berlin, Conn. One of the two 50-ft. steel arch bridges (that at Forest Hills), is shown in Fig. 5. It has five ribs, the skewbacks of which are laid radially so as to transmit a vertical pressure upon the foundations. This bridge was built by the Berlin Iron Bridge Co., of East Berlin, Conn. It will have the same flooring as the girder bridges, and this floor is shown in the illustration, which represents the inner rib of the first half of the bridge (for two tracks), the second half having been built after traffic had been transferred to the completed half of the bridge. The masonry bridge at Forest Hills (Fig. 4) has a central arch of 45 ft. span (square with the track), two arches of 41 ft. and two of 23 ft. span. All these arches are on a skew of 63°.

The method of erecting the plate-girder bridges is shown in Fig. 6. The plate girder is delivered on the work on a flat car, and the car is run upon the temporary trestle over the street. The longitudinal traveler is then moved sideways on transverse tracks until it is over the car. The girder is then raised, and the traveler carries it to its place, and lowers it upon the bridge seats. In the bridge shown, the width of street is such that no columns are used, but in wider streets a row of columns is erected on each curb line, so as to limit the span, and keep the depth of floor as small as possible. The width of the streets ranges from 40 to 80 ft.

The earthwork filling is done from the temporary double track trestle between the walls, and in some cases this filling is partially done before the walls are built, the top of the bank being wide enough for three tracks close together. Then after the walls are finished the filling is completed. In the finished work the width will be about 59 ft., the four tracks being 13 ft. c. to c., with 10 ft. from the center of each outer track to the wall. The material is obtained from a gravel pit 13 miles distant, and the gravel train service is very carefully organized. Small dump cars were at first tried, but gave much trouble by getting derailed, and flat cars used were found to be unsatisfactory by reason of the time occupied in unloading them. As now organized the train consists of 20 eight-wheel Pratt dump cars of 25 cu. yds. capacity each, or 500 cu. yds. per train. The train is hauled by a powerful mogul engine. There will be about 1,000,000 cu. yds. of filling altogether, and 870,000 cu. yds. had been put in place by the end of November. The work goes on at the rate of about 13,000 cu. yds. per week, or 60,000 per month. One shovel is usually employed, loading one train while another is on the work, but another shovel is put in service if the first cannot keep the trains supplied. This work goes on night and day. With two shovels at work, 3,500 cu. yds. (or seven train loads) have been dumped in 24 hours. The unloading is attended to by groups of men on the track, who also attend to the ballasting, lining, surfacing and general work on the track. All the details of cost, etc., are very accurately recorded.

The material is a good quality of clean gravel, excellent for filling, and making serviceable ballast for temporary use. The filling costs from 17 to 25 cts. per cu. yd., in place, including excavation, hauling and unloading, and temporary track work.

As already noted, the dump cars are of special design, patented by Mr. E. E. Pratt, Superintendent of Buildings of the N. Y., N. H. & H. R. R., and built by the company. They are 28 ft. long inside, rated at 60,000 lbs. carrying capacity, and weighing 25,100 to 25,650 lbs. empty. The sides are made in two parts, divided horizontally. When the train stops the upper half of the side of the car is swung up and half the load dumped. The train then moves on a train length and the lower half of the side of each car is swung down, dumping the rest of the load.

The old line originally had four tracks. In preparing for the new work the two middle tracks

were abandoned, and new temporary tracks were laid on the eastward side of the right of way, while a substantial double-track trestle was built over the middle at the elevation of the new grade. One of the old tracks was retained as a service track for handling material without any interference with traffic, as shown in Fig. 3. The trestle has framed bents of 12×12-in. timbers, with ample longitudinal diagonal bracing of 3×10-in. planks. It was made of very heavy construction, as fast express trains are liable to be stopped on it by signal, introducing somewhat severe longitudinal strains. Each track has two outside guard timbers and has also an inside guard rail laid close to the inner running rail, as shown in Fig. 3. Nobody is allowed on the trestle except a watchman who patrols it continually, and is provided with a wrench and water bucket. Fences are built at stations to prevent people from getting off the cars on the wrong side of the train and falling from the trestle. A large part of the embankment or filling in is already completed, and Fig. 5 shows the old surface tracks and the new elevated tracks. There are about 240 trains per day, running in close succession during the busy hours, and this traffic is carried on without interference with the work. No slow boards are put up, but trains are simply required to occupy a certain time in traversing the length of the trestle, so as to avoid any possibility of alarm to passengers by high speeds on this structure. The two main tracks can only be occupied by work trains for a few hours each night.

At Forest Hills and one other station the freight yards have had to be raised to the new grade. One difficult piece of the work was moving the interlocking plant at the junction of the Roxbury branch with the main line at Forest Hills. This plant was first moved sideways to make room for the elevated tracks, and was then raised upon the trestle, this being all accomplished without interfering with the traffic. There are five stations on the line, and these are simple but attractive buildings designed in the railway company's offices. Glazed yellow brick, hardwood finish and hammered iron lamp fixtures, etc., are among the features of the interior work. They are all double stations, with buildings on each side of the track. Passengers will not be allowed to cross the tracks, but there will be a fence between the tracks, a subway being provided at each station, and outside steps will lead from each end of the platforms to the street level.

Among the incidental works undertaken was the diversion of Stoney Brook, an open watercourse which came within the limits of the new embankment where the masonry retaining walls were not built. A concrete channel or culvert 17 ft. wide and 15 ft. 6 ins. high was built parallel with and 35 ft. from the old natural channel, and at the Stoney Brook gatehouse (of the Street Department of the Sewer Division of the city of Boston) a sand catch basin and an iron screen for driftwood have been built.

Detailed records are kept of the progress and cost of the work, and a large number of photographs are taken showing the work in its various stages. Blue prints of these photographs are pasted in a scrapbook in order of date. The following are the general rules ,printed in double column on folded cards 7×5¼ ins., and issued to the engineers and inspectors on the work for their general guidance:

Office of Asst. Engineer of Construction, N. Y., N. H. & H. R. R., Old Colony System, Jamaica Plain, Mass.

Rules for the Government of Engineers and Inspectors.

Main tracks must be kept clear for the safe passage of trains at all times.

Contractors are not allowed to cross main tracks with materials, except in the usual way at street crossings that are protected by gates.

In case of an accident where one or more of the main tracks is obstructed, the first thing to do is to send flags out in both directions, at the same time notifying, by telegraph, this office, and also the office of the Superintendent in Park Square Station, Boston, of the nature of the accident, what tracks are blocked, and how long it will take to clear them. Take all the men in call on the work to clear the tracks.

Contractors must provide and keep along the work sets of emergency tools, such as axes, saws, tackle, etc., where they can be got at in case of accident.

Telegraph wires must not be interfered with. In case they are in the way, notify this office that a lineman is needed to look after them, and they are not to be touched without his consent.

All derricks that are set up so that the boom can reach over a main track must have boom fastened with guy rope, or posts must be set in the ground so as to prevent it swinging out over the main track at any time.

Foremen must inspect all guys every morning at each derrick.

In case it is necessary to take a guy line across tracks, permission must first be asked of this office for necessary flagman (and lineman for wires if required), and the crossing of tracks with line must be done under direction of the Section Boss, and under flags put out in both directions to protect trains.

Contractors' men are not allowed to fasten guys or the like to the tracks or to the false work carrying tracks.

Contractors must not unload from cars on Construction track while regular trains are passing or approaching on main tracks.

Contractors will be allowed to work near the Construction track, provided flags are put out in both directions at least 500 feet away on this track.

At no time must the Construction track be blocked in such a manner that it cannot be at once freed. Trains must be expected on this track, in either direction, at any time.

All guys, where crossing tracks, must be at least 22 feet in the clear above the top of rail.

Contractors must have all excavations that are made near public travel, and all obstructions in public highways, properly protected by fences, and well lighted at night.

During heavy rain storms, Engineers and Inspectors must be upon their work to guard against all possible accidents.

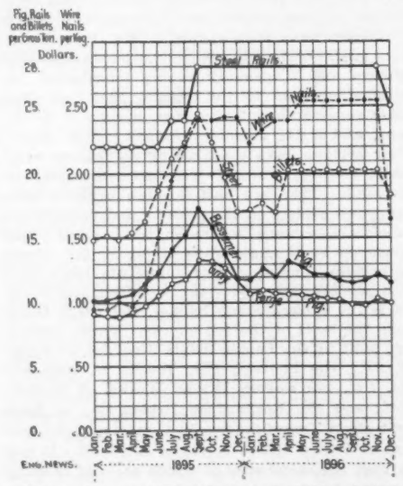
No excuse will be taken for disobedience of orders or carelessness, and Inspectors will report any violation of rules or any carelessness on the part of Contractors' men.

Per order, C. M. Ingersoll, Jr.,
Asst. Engr. of Const.

Work was commenced in the autumn of 1895, and is to be completed in the spring of 1897. The execution of the work is under the entire charge of Mr. C. M. Ingersoll, Jr., M. Am. Soc. C. E., Assistant Engineer of Construction, to whom we are indebted for blueprints, photographs, and information used in the preparation of this article. The work is, of course, under the general supervision of Mr. F. S. Curtis, M. Am. Soc. C. E., Chief Engineer, and all arrangements for changing train service from one track to another are made between Mr. Ingersoll and Mr. C. A. McAlpine, Division Superintendent of this division of the New Haven system.

## IRON AND STEEL PRICES IN 1895 AND 1896.

The accompanying diagram is an interesting exhibition of the course of prices in the iron and steel business during the last two years, showing especially the effect of combinations and pools upon the prices of certain products. The period was a notable one in many respects. In April, 1895, a short-lived boom in prices began, which advanced the price of Bessemer pig iron at Pittsburg from less than $11 per ton in April to more than $17 per ton in September, but the supply




Prices of Iron and Steel Products in 1895 and 1896.

soon caught up to the demand, and the price fell below $12 in December. During the period of advancing prices the steel rail manufacturers advanced their price from $22 to $28 per ton. They did not lower the price, however, when the price of pig iron fell, but held it steady for 15 months, when a reduction of $3 was made.

Early in 1895 the nail manufacturers entered into a combination, and gradually advanced the price of wire nails from 95 cts. to $2.55 per keg. The combination broke in Dec., 1896, after a life of about 18 months, and the price dropped to $1.65 per keg. Steel billets, on which there was no combination in 1895, fluctuated with the price of Bessemer pig iron, rising from $15.42 per ton in April to $24.35 in September, and falling to $17 in December. The price remained nearly steady for the next four months, when a combination of manufacturers was formed and the price was put up to $20.25. This price was firmly held until December, when the refusal of one concern to remain in the combination broke the price, as low figures as $15 having been named in the present month.

Before the "boom" in 1895, or from January to April, the price of Bessemer pig at Pittsburg ranged between $10 and $10.70 per ton. After the boom was over and during the whole of 1896, during part of which year the trade depression was as great as at any time in 1895, the price never went below $11.30, ranging from that figure to $13.10. The maintaining of prices at this relatively high level, as compared with those of Jan. to April, 1895, was not due to an agreement of manufacturers, but to the fact that pig iron costs more to make, especially by those furnace owners who did not own an ore and coke supply. Ore and coke prices were controlled by combinations and agreements during 1896, and there was probably no greater profit in 1896 to the pig iron manufacturer who was compelled to buy his ore and coke than there was in 1895.

It used to be said by political economists that prices were governed by supply and demand. It is evident that this statement needs to be modified if it is to be applied to the iron trade, so as to read, "prices are governed sometimes by supply and demand and sometimes by pools."

The figures used in plotting the diagram are average monthly prices at Pittsburg, taken for 1895 from the "Bulletin of the Iron and Steel Association," and for 1896, from the "American Manufacturer." The figures are as follows:

Prices of Iron and Steel Products at Pittsburg.
(Pig iron, rails and billets in dollars per gross ton; Nails in dollars per keg.)

| | —Pig iron— | | Bessemer | | |
|---|---|---|---|---|---|
| 1895. | Bessemer. | Gray forge. | steel billets. | Steel rails. | Wire nails. |
| January | $10.06 | $9.17 | $14.79 | $22.00 | $0.95 |
| February | 10.15 | 9.09 | 15.01 | 22.00 | .95 |
| March | 10.23 | 8.99 | 14.94 | 22.00 | 1.00 |
| April | 10.69 | 9.27 | 15.42 | 22.00 | .95 |
| May | 11.15 | 9.81 | 16.25 | 22.00 | 1.10 |
| June | 12.39 | 10.55 | 18.85 | 22.00 | 1.50 |
| July | 14.14 | 11.45 | 21.06 | 24.00 | 1.95 |
| August | 15.02 | 11.97 | 22.05 | 24.00 | 2.20 |
| September | 17.19 | 13.37 | 24.35 | 28.00 | 2.40 |
| October | 15.77 | 13.12 | 22.19 | 28.00 | 2.40 |
| November | 13.94 | 12.65 | 19.90 | 28.00 | 2.42 |
| December | 11.87 | 11.85 | 17.00 | 28.00 | 2.42 |
| 1896. | | | | | |
| January | 11.95 | 10.85 | 17.05 | 28.00 | 2.25 |
| February | 12.69 | 11.00 | 17.69 | 28.00 | 2.33 |
| March | 12.90 | 10.75 | 17.00 | 28.00 | 2.40 |
| April | 13.10 | 10.75 | 20.15 | 28.00 | 2.40 |
| May | 12.85 | 10.75 | 20.25 | 28.00 | 2.55 |
| June | 12.33 | 10.57 | 20.25 | 28.00 | 2.55 |
| July | 12.15 | 10.35 | 20.25 | 28.00 | 2.55 |
| August | 11.40 | 10.15 | 20.25 | 28.00 | 2.55 |
| September | 11.31 | 9.81 | 20.25 | 28.00 | 2.55 |
| October | 11.60 | 9.75 | 20.25 | 28.00 | 2.55 |
| November | 12.25 | 10.25 | 20.25 | 28.00 | 2.55 |
| December | 11.50 | 10.00 | 18.29 | 25.00 | 1.65 |

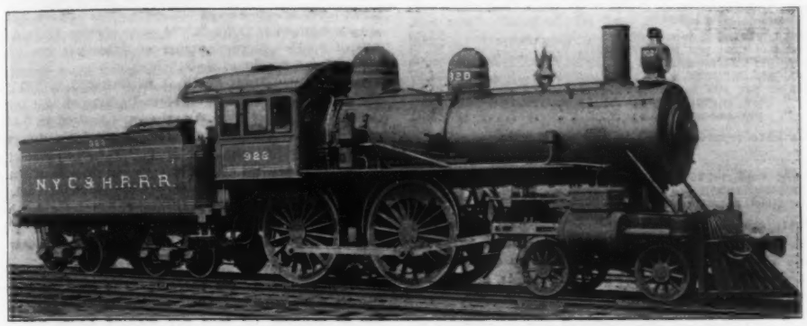
## FAST EXPRESS LOCOMOTIVES FOR THE NEW YORK CENTRAL & HUDSON RIVER R. R.

Among the latest additions to the motive power equipment of the New York Central R. R. are ten engines of the eight-wheel type built for handling fast and heavy trains. The grate area and heating surface are very large, and the driving and truck axles have unusually large journals, while the piston rods are extended through the front covers, as this has been found to very considerably reduce the trouble from wear of cylinders and breakage of piston rods. Five of these engines have driving wheels of 6 ft. 6 ins. diameter (as shown in the accompanying cut) and the others have wheels 5 ft. 10 ins. diameter. In all other respects the engines are duplicates. Their general dimensions (given in our standard form) are as follows:

Eight-Wheel Express Locomotive; N. Y. Central R. R.

| | | |
|---|---|---|
| Running Gear: | | |
| Driving wheels, diameter | 6 ft. 6 ins. | |
| Truck wheels, diameter | 3 " 0 " | |
| Tender wheels, diameter | 3 " 0 " | |
| Engine truck | Rigid center. | |
| Journals, driving axles | 9 | × 12½ ins. |
| " truck axles | 6¼ | × 10½ " |
| " tender axles | 4½ | × 8 " |
| " main crank pins | 5½ | × 5¼ " |
| " side rod pins | 4½ | × 8¼ " |

| | |
|---|---|
| Wheelbase: | |
| Driving | 8 ft. 6 ins. |
| Total engine | 23 " 11 " |
| " tender | 15 " 10½ " |
| " engine and tender | 48 " 9½ " |
| " length of engine and tender | 58 " 4⅜ " |
| Weights in Working Order: | |
| On driving wheels | 90,000 lbs. |
| On truck wheels | 46,000 " |
| Engine, total | 136,000 " |
| Tender, empty | 43,220 " |
| Cylinders | 19 × 24 ins. |
| Piston, thickness (horizontal) | 5 " |
| Piston rod (hammered iron), diameter | 3⅞ " |
| Valve Gear: | |
| Steam ports | 18 × 1¼ " |
| Exhaust ports | 18 × 2¾ " |
| Bridges | 1⅛ " |
| Slide valves | Richardson balanced. |
| " " travel | 5½ " |
| " " lap; inside, none; outside | 1 in. |
| " " lead in full gear | 1-16-in. |
| Boiler: Type | Wagon-top. |
| Diam. first ring, outside (smokebox jacketed) | 5 ft. |
| Thickness of barrel plates | 9-16-in. |
| Thickness of throat plate | ⅝-in. |
| Thickness of smokebox tube plate | 9-16-in. |
| Working steam pressure | 190 lbs. |




**EIGHT-WHEEL EXPRESS LOCOMOTIVE; NEW YORK CENTRAL & HUDSON RIVER R. R.**
**Wm. Buchanan, Supt. of Motive Power. Schenectady Locomotive Works, Builders.**

| | |
|---|---|
| Firebox: | |
| Length, inside | 9 ft. ⅛-in. |
| Width, inside | 5 " 4⅞ " |
| Depth at front | 6 " 2½ " |
| Depth at back | 4 " 10½ " |
| Thickness of side plates | 5-16-in. |
| " of back plate | 5-16-in. |
| " crown sheet | ⅜-in. |
| " tube sheet | 9-16-in. |
| Crown bars (welded at ends) | ¾ × 5 ins. |
| Grate area | 30.69 sq. ft. |
| Staybolts, diameter | ⅞ and 1 in. |
| Water space, width; front, 4 ins.; sides, 3 ins.; back, | 3 to 4½ ins. |
| Tubes, charcoal iron; number | 288 |
| Diameter outside | 2 ins. |
| Length over tube plates | 12 ft. 1⅛ " |
| Thickness | No. 11 W. G. |
| Heating Surface: | |
| Tubes | 1,890.56 sq. ft. |
| Firebox | 158.23 " " |
| Water tubes | 12.93 " " |
| Total | 1,980.72 " " |
| Miscellaneous: | |
| Exhaust nozzle, double., diameter | 3¼ ins. |
| Smokestack, inside diameter | 1 ft. 4 " |
| Smokestack, height from rail to top | 14 " 8 " |
| Capacity of tank | 4,500 gallons. |
| Capacity of coal space | 17,000 lbs. |
| Brake fittings | Westinghouse. |

These engines are in fast service on the Empire State Express, the Fast Mail and the Chicago, St. Louis and Cincinnati limited trains, and they have made some exceptionally fast time on these trains. On Dec. 1, engine No. 924 made the run with the Empire State Express from Syracuse to Albany, a distance of 147.84 miles, in 2 hrs. 30 mins., including a 3-minute stop at Utica, together with a slow-down through Schenectady and a slow-down through the streets of Syracuse, a distance of about 1½ miles, in compliance with that city's ordinance limiting the speed to 8 miles per hour. Deducting 10 minutes for the time in running the 1½ miles in Syracuse and the 3-minute stop at Utica, leaves the running time from the city limit of Syracuse to Albany, 2 hrs. 17 mins. Deducting the 1½ miles in Syracuse from the total distance leaves 146.34 miles, and the record is thus 64 miles per hour for the 146.34 miles, not allowing for the slow-down through Schenectady.

The engines were built to specifications and drawings prepared by Mr. Wm. Buchanan, Superintendent of Motive Power and Rolling Stock of the New York Central & Hudson River R. R., and though somewhat similar to those previously designed by Mr. Buchanan, and which are rendering efficient service, they possess many special features of improvement. They were built by the Schenectady Locomotive Works, of Schenectady, N. Y., to whom we are indebted for photographs and specifications.

The driving wheel centers are of gun iron, with Midvale steel tires shrunk on and held by retaining rings. The driving boxes are of Magnus metal. The driving axles, truck and tender axles, piston rod, and main crank pins are of hammered iron, and the side rods are of Midvale steel. The engine truck is of the rigid-center type, with spring side bearings, and has Krupp steel wheels with open-hearth steel tires 2⅝ ins. thick, secured by retaining rings. The pistons are of the solid head, box form, with three cast-iron packing rings. The piston rods are extended through the front cylinder heads, and both piston rods and valve stems have the United States metallic packing.

The boiler is of the wagon top type, with circumferential seams double riveted, and the horizontal seams made with butt joints sextuple riveted, having welt strips inside and outside. The boiler and firebox are of carbon steel, and the crown sheet is supported by crown bars ¾ × 5 ins. welded at the ends, while the mud ring is double riveted. The staybolts are of Brown & Co.'s United States iron. The firebox has a firebrick arch supported on water tubes. The railway company's style of rocking grates is used, and the ashpan is sectional, with dampers at front and back. The boiler lagging is of asbestos cement. The springs were made by the builders. The tender has a frame of angle iron ¾ × 4 × 6½ ins., and is carried on the railway company's style of side-bearing trucks with wooden bolsters, the wheels being of Krupp steel, with 2⅝-in. open-hearth steel tires secured by retaining rings. It is fitted with a water scoop for taking water from the track tanks.

The engine has two Monitor injectors (a No. 9 and a No. 10), two 3-in. consolidated muffled safety valves, Nathan triple sight-feed lubricators, Star round-case headlight, Ross-Meehan brakeshoes, American steel brakebeams on the tender, the Gould coupler on the pilot and long-shank coupler on the tender. It is equipped with a 9½-in. brake pump, the Westinghouse air signal and the Westinghouse automatic air brake on driving wheels, tender and train.

## THE PERFORMANCE OF TWO-CYLINDER COMPOUND LOCOMOTIVES ON AMERICAN RAILWAYS.*

By John H. Cooper, M. Am. Soc. M. E.

I have the pleasure of presenting in detail the following results obtained during the year 1896, in regard to the working of compound locomotives. These results relate exclusively to comparisons of performance between two-cylinder compounds and simple engines, when alike in every respect except the compounding devices, working under similar conditions.

Two-cylinder compound locomotives may be treated under three heads or types, which may be defined in general terms as follows:

1. Those in which the intercepting valve is automatic and which cannot be run as a simple engine. This type is without a reducing valve.

2. Those in which the intercepting valve is operated by steam, but is under the control of the engineman, and is provided with a reducing valve, which is automatic.

3. Those in which the intercepting valve is operated by a rod connection from the cab, under control of the engineman, either by hand or by steam or by air; this type also has a reducing valve, which is automatic, allowing the engine to be run either simple or compound, at will.

These types will be found fully illustrated and described in the technical journals.

Should it be desirable to obtain the results of the working of other types of compounds, in order that the comparison shall be of value to railway men, the data must come from persons running them with simple engines of like size and type, under exactly the same conditions as has been done in the case of the two cylinder compounds.

The simple engine constitutes the standard of cost and running expenses, and is, therefore, the measure for ascertaining the commercial value of the several systems. Were this comparison obtained there would be little difficulty in determining the relative value of every type of compound, providing the performances of the simple engines exhibit such a similarity of result as will admit of easy and correct equating.

The writer and his colleagues, who have aided him in obtaining the facts here presented, have been particularly requested to withhold names of persons, roads and locomotives for reasons best known to the parties furnishing the data. Whether authorities are given or not, they offer truth for authority, upon which they rest our case. They have been careful in getting these results of performance that they should be derived solely from the official records, which are made by persons whose duty it is to furnish the facts of experience.

The following are extracts of performance sheets of twelve compound engines having cylinders 21 and 31 × 24 ins.; also of a simple engine, which is an exact duplicate of the compounds, except that the cylinders are single expansion. This engine carried the same steam pressure as the compound, and worked under precisely the same conditions. These reports are for May and June, 1894, being the last ones received, and were furnished after the engines had been in use more than a year:

Extracts from Performance Sheets.

| | May, 1894. Consolidation. | | June, 1894. Consolidation. | |
|---|---|---|---|---|
| | Compound. | Simple. | Compound. | Simple. |
| Miles run, freight service | 16,520 | 2,425 | 13,478 | 1,827 |
| Cost, mile, oil and waste, cts. | .34 | .33 | .34 | .42 |
| Cost per mile for fuel, cts. | 13.52 | 16.66 | 11.68 | 18.09 |
| Miles run to 1 pt. valve oil | 53.02 | 86.61 | 63.07 | 39.72 |
| Miles run to 1 pt. engine oil | 21.34 | 14.97 | 17.81 | 14.50 |
| Coal, loaded fr't. car-mile, lbs | 3.41 | 4.46 | 3.43 | 4.30 |
| Miles run to 1 ton of coal | 21.49 | 17.43 | 25.08 | 16.13 |

Youghiogheny and Hocking Coal Used.

| | | |
|---|---|---|
| Cost of fuel-wood per cord | $1.86 | $1.86 |
| Cost of fuel-coal per ton | 2.87 | 2.87 |

All conditions should be alike, save the compounding, and then the engines should be manned alike and have the same character of fuel, substantially the same loads, weather, etc. Further than this, the trial should be of sufficient length to carry it down to every-day work, and should cover the changing of enginemen and firemen, as well as all the vicissitudes of weather and work. In no other way can we answer the criticisms or overcome the scepticism of many regarding the value of the compounding principle. We must be able to show that we not only do save fuel, but that we do not have excessive repairs arising from the changes in machinery.

The writer, in ordering a lot of engines, had one ten-wheel passenger out of three (built on the same specifications) compounded, and two consolidation freight engines compounded out of 18, all on the same specifications. The weight of all these engines was the same, 126,000 lbs., without the tender, and they were delivered and put into service about the same time. The simple consolidation engines had cylinders 20 × 24 ins. while the compounds had 20⅝ and 20 × 24 ins. The cylinders of the ten-wheeled simple engines were 19 × 24 ins., while those of the compound were 19 and 27 × 24 ins. The consolidations were substantially duplicates of a large number of other engines of the same character, which, after some years' use, had been worked up to a very economical point. During the previous years we had procured a ten-wheel passenger engine, which had been changed, experimentally, until it had become unusually economical in fuel. This was the basis of the three new ten-wheel engines, and they were found most excellent in their workings.

The comparisons of the ten months' work of the passenger engines are shown in the following tables:

Passenger Engines.

| Engines | Miles run. | Car-miles. | Ave. cars per train. | Lbs. coal consumed. | Lbs. coal per car-mile. |
|---|---|---|---|---|---|
| One compound | 48,100 | 254,204 | 5.17 | 2,097,911 | 8.252 |
| Two simple | 107,885 | 564,995 | 5.23 | 6,263,654 | 11.086 |

Saving, 2.834 lbs. of coal per car-mile, or 25.56%.

*From the Journal of the Franklin Institute, January, 1897.

The work of four simple and two compound freight engines for eleven months is shown, as follows:

| Engines | Miles run. | Car-miles. | Ave. cars per train. | Lbs. coal consumed. | Lbs. coal per car-mile. |
|---|---|---|---|---|---|
| 4 smpl.,[1] 6 mos. | 81,226 | 1,335,045 | 16.43 | 8,252,533 | 6.132 |
| 4 smpl.,[2] 5 mos. | 61,318 | 1,190,786 | 19.41 | 5,977,917 | 5.029 |
| Total, 11 mos. | 142,544 | 2,525,831 | 17.23 | 14,230,450 | 5.634 |
| 2 comp.,[1] 6 mos. | 27,682 | 495,050 | 17.88 | 2,454,142 | 4.957 |
| 2 comp.,[2] 5 mos. | 31,550 | 712,291 | 22.57 | 2,667,505 | 3.746 |
| Total, 11 mos. | 59,232 | 1,207,341 | 20.38 | 5,121,647 | 4.242 |

[1]East End. [2]West End.

Saving, 1.392 lbs. of coal per car-mile, or 24.70%.

Here we have a marked saving in a year's work. We believe the conditions were such that the test is of more value than were the first ones made, as it shows the every-day work of the compound engines compared with exactly the same simple engine under the usual working conditions. No tests can be fairer, and I have seen none of more value.

I regret to state it, yet it is true, that there was at the start a universal prejudice against the compounds among the enginemen and firemen. They were pronounced failures before they were set up, and long after they had shown their good qualities the unfavorable criticism continued. "They would not start the train," but they did it. They "could not run up the long hills," but somehow they did it quite as easily as the other engines. They "could not pull within two or three cars of the other engines," but a year's work showed they averaged larger trains, and in repeated cases, they have pulled as heavy trains as any engines on the road. When the men saw the compound passenger engine run the round trip with a tender of coal, and run easily 100 miles with one tank of water, they had to admit that there was some good in the new departure.

It is our belief that this test of nearly a year in every-day work, with changing enginemen and firemen, against exactly similar simple engines, doing the same work at the same time, is more valuable than any tests yet reported in this country, and demonstrated beyond a question the value of the compound principle in locomotive engines, in the matter of coal consumption. The importance of this is seen when it is known that the cost of fuel is about 10% of the whole cost of operating, and when we consider that the 32,000 locomotives in this country probably consume 30,000,000 tons of coal per annum.

There is, however, another matter to be considered, and it is one that has rendered American engineers sceptical as to the real value of the compound engine; that is, one of repairs, as well as first cost. It stands to reason that the cost of maintaining three cylinders or four cylinders will be larger than the cost of maintaining two. I have a report of the repairs upon the engines under consideration from Jan. 1 to June 30, 1891, a period of six months, while they were running together, and for six months of the time in which the consumption of coal is considered. This report is for engines running at the same time and over the same ground:

| | Engines—Four simple. | Engines—Two compound. |
|---|---|---|
| Miles run in 6 months | 76,827 | 39,268 |
| Total cost of running repairs done | $1,312.66 | $612.72 |
| Cost per mile run, cts. | 1.70 | 1.55 |

This shows that for six months the compound ran more economically than the simple, as far as repairs are concerned. It is quite probable, however, that in another six months this would be evened up, and the cost per mile would have likely been equal to that of the simple engines.

When we consider that with cheap coal (say $1.50 per ton) the cost per engine-mile for fuel is, for freight trains, about 7 cts. per mile, and for passengers 4½ cts., we can see that a saving of even 20% in fuel means over 1 ct. a mile, and that it cannot be outweighted by any reasonable, or I may say possible, increase of repairs, as but a small part of such repairs pertain to, or are affected by, the parts compounded.

We believe this to have been a good practical test of the two-cylinder type of compound engines, and while no claim is made to perfection, it seems to have covered a sufficient length of time, amount of work and variety of climatic and other conditions, to have overcome the influence of any prejudices, or efforts for or against any particular engine or of any special skill on the part of any one man, that in a short run or experiment might have a marked effect.

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Where coal costs from $3.50 to $4 per ton, of course economy in the quantity consumed is a matter that is looked after. One of these two-cylinder locomotives has been running for about three years past, and the reports we have received from the officials of the railway company go to show that the saving in fuel, due to the compound system, has averaged about 17%. comparing it with simple engines of the same type and capacity, doing practically the same work and run on the same division. The saving of fuel in the case of the other four compounds on the same line which have been in service for about one year past, is said to be about the same (17%) as compared with the simple engines. No special tests or efforts have been made, so far as we know, in the matter of saving fuel; but the results are obtained from the monthly reports of fuel consumed by the locomotives on the line.

The reports as to the cost of repairs of these compounds indicate that they are little, if any, more than the simple engines, doing the same work on the same line.

In the case of the other four compound locomotives, sent to another road, we have as yet received but little information as to their consumption of fuel. Some tests that were made, but continued for about ten days only, showed results that indicate a saving of about 20%. We think that on an average, "taking things as they come," the saving will result about the same as in the other case, namely, 17%.

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Four compounds are reported, one of them running two years, one ten months; in all running 117,945 miles in freight service and 2,946 miles in passenger service. Also, five simple engines, making 1,063,975 engine-miles in freight service and 3,324 miles in passenger service.

The chief results are in favor of the compounds, and are as follows:

| | Per cent. |
|---|---|
| Engine-miles per ton of coal | 25.36 |
| Pounds of coal per 100 ton-mile | 23.59 |
| Coal per engine-mile | 19.00 |
| " per car-mile | 24.17 |
| Water per 100 ton-mile | 28.85 |
| " per engine-mile | 16.84 |
| " per car-mile | 18.91 |

We have reports as follows:

| | Simple. | Compound. |
|---|---|---|
| On one road, repairs per train-mile, cts. | 2.1 | 1.5 |
| On another road, repairs per train-mile, cts. | 4.11 | 3.90 |
| On another road, repairs per train-mile, cts. | 3.13 | 2.88 |

These are all the data we have on repairs; and it will be noticed that the compound beats the simple by about 13%. The data on lubrication show that on one road the compound used 12% more oil than the simple, and on another road 17% less.

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Without giving you the results of any experiments or tests, I should say, in a general way, that a compound locomotive, when new, will save about 25% in fuel over a simple engine. I am convinced from our experience here that the compound engine in passenger service is of great value for fast trains, because a run of a hundred miles can be made with one tank of water, thus avoiding any stops, except at division terminals. The use of such engines avoids the necessity for building track tanks, and of course is a great saving. In addition to this, the engines run very much cleaner and make but little smoke when properly handled.

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The performance of your two-cylinder compound engines is in every respect superb. We have had an engine in our express freight service, in competition with two simple moguls with 19 × 24-in. cylinders, carrying 160 lbs. working steam pressure. These engines are all rated the same, being all given trains of 700 tons each. The consumption of coal is as follows: Compound engine ran in April, 1895, 31.1 miles per ton of coal; while the two moguls averaged 16.2 miles per ton.

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These engines are designed to carry 200 lbs. steam pressure. They are as nearly alike as possible, although they vary somewhat in their weight. The total weight of the compound is 127,500 lbs., and of the simple engine 117,460 lbs. Average steam pressure on test, 150 lbs. Average amount of coal burnt each trip: compound, 6,150 lbs.; simple, 6,414 lbs. Average coal per car-mile in pounds: compound, 6.72; simple, 7.55. Average pounds of water evaporated per pound of coal: compound, 7.86; simple, 6.67. Relative amounts of coal burned on basis of car-mile: compound, 100%; simple, 112.35%.

The cost of the maintenance of these locomotives in a test occupying so short a time plays no part. The engines, prior to the test, were put in first class condition, practically as good as new, and the repairs amounted to nothing.

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We have in service three two-cylinder compound engines. They have been in service since November, 1891, and we are very well pleased with the general results given by them. They show from 30 to 33% saving in fuel; about 25% in evaporation. While there is no claim made for saving in repairs, we find that the cost of repairs is only a fraction of a cent more than the simple engine. The engines are virtually simple engines, having but two cylinders and no complication of parts over simple engines, with the exception of one intercepting valve and one reducing valve. Those comparisons were made with simple engines running in the same service and under the same conditions.

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We have in service two ten-wheel compound engines of the two-cylinder type and a large number of ten-wheel simple engines, which, with the exception of the compound feature, are duplicates of the two compound engines. These engines have been used in freight service entirely, with the exception of a very small amount of passenger service, and I take pleasure in submitting below a comparative statement of the performance of the engines mentioned during the past five years:

| | Simple. | Compound. |
|---|---|---|
| Cost per mile for oil and waste, cts. | 0.18 | 0.2 |
| Cost per mile for repairs, cts. | 2.49 | 3.69 |
| Miles run per ton of coal | 20.51 | 22.5 |
| Pounds coal consumed per car-mile. | 3.10 | 3.18 |
| Total cost per car per mile, cts. | .56 | .6 |

I will give you the figures as returned to me by our comptroller, of the performance of these engines in regard to fuel. In the month of May, 1895, a compound engine, in passenger service, made a mileage of 5,558; her average number of miles per ton of coal was 49.5. Simple engine, in the same service, running opposite to the compound, made a mileage of 4,843, and her average mileage per ton of coal was 41. These two engines were on night runs, consisting of seven-car trains, postal and baggage cars, two coaches and three sleepers, all vestibule.

We have had the passenger engine for about eighteen months, and she has given entire satisfaction; is very economical on repairs and especially so on fuel. In our freight service we have a two-cylinder compound engine which, in the month of May, on our fast freight schedule, made 3,003 miles—average miles per ton of coal, 33. Our simple engines running in the same service made a mileage of 2,800—average number of miles per ton of coal, 19.2. Same weight of train.

The distance from terminal to terminal is 143 miles. The simple engines are limited to 7½ tons of coal per trip, and the compound freight engine was limited to 5 tons of coal per trip. I have had no complaint from the engineman running the compound engine of being short of fuel, but I had several complaints from the men running the simple engines where they were short of fuel. The compound engines, both passenger and freight, show a remarkable saving of fuel, and we are highly pleased with their performance.

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To say the least, we are very highly pleased with the two-cylinder compound engines. The legitimate cost of repairs is no greater than on the simple engines. In the use of cylinder oil they are making about double the mileage of the simple engines, and, on fuel, they are saving at least 25%.

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I am pleased to record the fact that we have had 19 of your engines in our service from two to three years, and they have given most excellent satisfaction, both in character of workmanship and effective working and maintenance. It is a special pleasure to record the advantages afforded by your type of compound engine, evinced by their economy of fuel and moderate repairs.

## A BROOKLYN AND NEW YORK RAPID TRANSIT TUNNEL.

The commission appointed by the Mayor of Brooklyn, N. Y., to devise some plan for removing the steam railway traffic from the surface of Atlantic Ave., and for improving the rapid transit facilities on that avenue, has now presented its report, which is an important one, as it proposes plans for handling traffic between Brooklyn and New York as well as the local city traffic. In brief, the plan proposed is for a rapid transit electric line (partly elevated and partly in tunnel), with a tunnel under the East River and a terminal station at Cortlandt St. and Church St., New York. The following is an extract from the report:

The proposition is to have a low level station at Cortlandt St., New York, about 70 ft. below ground, connecting with the streets and the elevated roads in that city by means of elevators, the tunnels being carried thence to a station at Maiden Lane and Pearl St., with connections with the Second and Third Ave. railways; thence under the East River, under Pineapple St. and Fulton St. to a station near the City Hall, Brooklyn; from thence under Fulton St. and Flatbush Ave. to the Flatbush Ave. station, where it would be about 18 ft. below grade. The tunnel will be carried under the Brooklyn streets within the curb lines to a station at the City Hall, which it will be 115 ft. below the street grade, and will rise by an easy grade from that point so that the bottom of the tunnel shall come above the main relief sewer at Flatbush Ave. and Hanson Place, before passing into the depressed station.

Continuing from Flatbush Ave. station, along Atlantic Ave., the tracks are depressed to Bedford Ave., a distance of 6,700 ft., the depression being covered by means of girders and masonry arching, restoring the surface of the street for public use for its full width. From the east side of Bedford Ave. the railway tracks will rise rapidly in an open cut to the grade of the street and, continuing to rise, will pass onto an elevated railway structure, which, at Nostrand Ave., will attain such height that full head room will be provided for all street traffic without interference.

The physical characteristics of the ground between Bedford and Nostrand Aves. are such that the rising grade

of the railway and the falling grade of the street combine to favor this transition from a depressed to an elevated structure, so that no obstruction is caused to any existing cross street, and full advantage is taken of the length of this block between Bedford and Nostrand Aves. (which is the longest on Atlantic Ave). At Nostrand Ave. an elevated station is proposed and the elevated structure continues thence a distance of 8,010 ft. to Ralph Ave.

The posts of the elevated structure are 22 ft. 3 ins. apart, and the street being 120 ft. wide, will give ample space for all road traffic necessary. The extreme width of the elevated structure at the top surface is 32 ft., and being designed to be of medium height, will not interfere with the light and air of the adjacent owners, as is the case with existing elevated railways, which generally cover a large proportion of the width of comparatively narrow streets. This plan saves great expense in construction, as it does not interfere with the many sewers in that section, nor with the water mains or the grade of the intersecting streets. The elevated section terminates between Ralph and Howard Aves., at which point the grade of the street rises rapidly going east; the tracks of the railway are then carried through a tunnel for a distance of 2,910 ft. to Stone Ave., thence the tracks rise to the present grade at Sackman St.

At Vesta Ave., in the Twenty-sixth Ward (which is better known as the Manhattan Crossing), owing to the complication of the tracks of the Manhattan Beach R. R., the railway from Long Island City, the elevated railway, the Canarsie railway and various sewers and water mains, the expense of changing the level of the railways at this point would be of such magnitude that it has been deemed wise not to remove them from the surface.

Plans are being prepared for providing new depot accommodations at this location that will greatly improve the present unsatisfactory conditions, as well as give better and safer facilities for the public street traffic.

At Snedeker Ave., one block east of Manhattan Crossing, the railway tracks will rise and continue as an elevated structure to Atkins Ave., where the tracks return to the surface grade, a distance of 6,070 ft. It will thus be observed that on the entire route west of Atkins Ave. along Atlantic Ave., excepting at Manhattan Crossing, all grade crossings are eliminated, and the use of the surface of the street is restored to the public without obstruction. It is also proposed to operate a line of railway by the trolley system, on the surface of the streets, thus replacing the existing rapid transit trains by a much more convenient and efficient service for short distance riders, while at the same time, it will distribute the passengers on the through trains to points intermediate between stations, and the through trains will be enabled to give true rapid transit by reason of the few stoppages.

The motive power for both systems will be electricity. The through service by short trains at frequent intervals and high speeds, will give accommodation never before offered. The freedom of this system from the nuisances of noise, steam, smoke and coal gas, will do away with many of the objections to former plans for the treatment of this problem.

We are able to state positively that the total cost of construction of the proposed railway along Atlantic Ave., from Flatbush Ave. to Atkins Ave., ready for use and operation, will not exceed $2,500,000. Estimates have been furnished to the commission by competent engineers, and the figures verified by Mr. Walter M. Meserole, a member of the commission, who is himself a civil engineer. This estimate may be reduced somewhat; at all events, it will not be increased. The city of Brooklyn's share in the expense of such construction will not exceed one-half the amount named.

The Long Island R. R. formerly had a line of steam cars running the whole length of Atlantic Ave. down to South Ferry (partly in tunnel), but many years ago, it was compelled by legislation to stop running its cars below Flatbush Ave., and it therefore established a terminal station at the junction of Flatbush Ave. and Atlantic Ave. From that point to East New York the double track occupies the center of the avenue, and though it is fenced in and is provided with gates at the numerous street crossings, there has been a long series of accidents at these crossings, by which many people have been killed. The appointment of the commission was the result of many years of fighting the present state of affairs, against the opposition of the railway company. The plan proposed appears to be a feasible and satisfactory one, with the added advantage of providing a new connection between the two cities, and the present indications are that the railway company is disposed to act in harmony with the commission, recognizing the importance of having a New York terminal for its enormous suburban traffic. It has long desired such a terminal and has been interested in more than one tunnel scheme and the Blackwell's Island bridge, none of which projects, however, have as yet materialized.

The commissioners who sign the report are Eugene P. Blackford, Edward F. Linton, Edward H. Hobbs, William E. Phillips, and Walter M. Meserole.

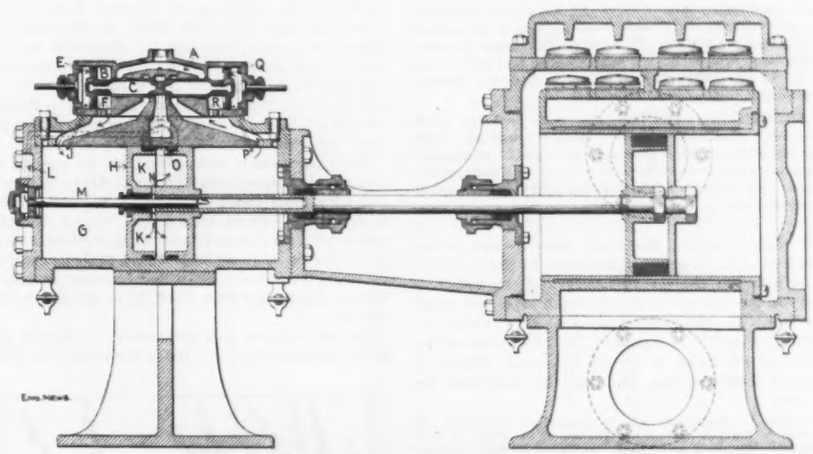
## THE MARSH VACUUM PUMP.

We illustrate herewith a vacuum pump made by the Battle Creek Steam Pump Co., of Battle Creek, Mich., which has several features of interest, particularly in connection with the valve gear controlling the steam supply. By an automatic governing arrangement the admission valve graduates the steam cylinder pressure to suit the varying resistance in the air cylinder—that is, the steam valve automatically weighs the load on the air piston, and admits just enough steam to perform the work to the best advantage. This operation will be understood by examining the accompanying sectional drawing.

The current of steam on entering the chest A passes to the left and through the annular opening B, formed between the reduced neck of the valve C and the bore of the first chest wall. It is thus projected against the inside surface of the valve head E before escaping through the port F and passing to the cylinder G. Both the pressure and the impulse due to velocity acting on the valve head E operate to restrict the opening of the annulus B by forcing the valve C to the left or in the direction of the current. When the steam reaches the cylinder G, driving the piston H toward the right, a "trip hole" J admits steam from the cylinder to the outer end of the chest chamber and the pressure of this steam tends to move the valve toward the right, and thereby to give a wider opening to the annulus B, thus admitting more steam to the cylinder. The valve C thus occupies a position depending upon the relative strength of two forces which tend to move it in opposite directions. If the piston moves easily, handling only air, the pressure of steam in the cylinder is correspondingly light, the force tending to open the valve is small, and it assumes a position nearly closing the supply. On the contrary, if the resistance to the movement of the piston is increased by entrance of water to the air cylinder, a movement of the valve in the opposite direction is accomplished by the higher pressure required to drive the piston, and enough steam is admitted to meet the increased requirements.

Having now explained that the steam valve is in a perfectly balanced position between admission steam which tends to close the valve, and cylinder steam which tends to open the valve wider, the manner of its reversal remains to be described. This is accomplished by means of the "trip holes" which, at the end of the stroke, register with the space between the rings of the hollow piston head, and which forms a reservoir supplied at all times with full chest pressure by means of the passages shown in dotted lines, and the central cap in the cylinder cover through the attached tube. This pressure is used only for the purpose of tripping or reversing the valve, by admitting steam against the enlarged heads of the valve through the connecting passages at either end of the cylinder. To explain in more detail, the space K between the piston heads is at all times supplied with steam at full chest pressure by means of the passage L, the cap and tube M and the ports N. Now, as the piston reaches the end of its stroke toward the right the packing ring O uncovers the "trip hole" P and the steam pressure in the piston space K passes through and acts on the valve head Q and forces the valve C to the left so as to cut off admission to the left port F. In the same movement the port R is opened for admission for the reverse stroke of the piston to the left. The operations at the right end of the valve and piston are now the same as those already described for the left end. It will be seen that a working stroke of full length is always secured as the exhaust does not take place until the small port is put in connected with the steam supply between the piston heads.

The water end of the pump requires no special explanation, its essential features being those well known as distinctive of the Marsh pumping engine. The piston rods are of Tobin bronze, and the air valves and seats, cylinder lining, rod boxes, etc., of the best phosphor bronze. These pumps are made in about 50 sizes, the smallest being 4 × 4½ ins. × 6-in. stroke. We are indebted to the Battle Creek Steam Pump Co., Battle Creek, Mich., for the matter from which this illustration and description have been prepared.




SECTIONAL DRAWING SHOWING CONSTRUCTION OF MARSH VACUUM PUMP.
Battle Creek Steam Pump Co., Battle Creek, Mich., Builders.

DOLLAR GAS AT WILMINGTON, DEL., will be the rule hereafter, according to press reports. The former price was $1.12.

A CHEAP DEVICE TO PREVENT THE FREEZING of a water main, apparently laid too near the surface, is in use in Rutland, Vt. The main is 8 ins. in diameter, and 329 ft. of it was burst by freezing in the winter of 1894-5. The committee on water proposed to lay a sewer in the street and maintain circulation in the water pipe by wasting water into the sewer. The pipe was purchased and the city engineer, Mr. Sidney Smith, was requested to give grades for laying it. He found that the sewer in that street, when built, should be designed to serve quite a territory, as yet sparsely populated, and should be provided with an underdrain to serve higher, wet land. He suggested that instead of building the sewer a well should be sunk into the porous material some distance below the surface and a hydrant branch be connected with it. Accordingly Mr. J. M. Davis, Superintendent of Water Works, sank a 12-in. sheet steel curb to a depth of 30 ft., removing the sand with a 6-in. stovepipe pump. A ¾-in. pipe was laid from the hydrant branch to the well and provided with a valve. The job cost $94, against $1,200 as the estimated cost of the proposed sewer. During cold weather the valve is opened and the water allowed to flow continuously to the well. During the winter of 1895-6, and up to Jan. 11, 1897, the water main has been kept from freezing by this device. We are indebted to Mr. Smith for the above information.

# ENGINEERING NEWS
AND
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A project which, from all that we can learn, promises to be of great importance to the carrying trade between the Great Lakes and tidewater, is that for the operation of a through lake and canal line from the upper lake ports to New York, via the Erie Canal. A company, to be known as the Consolidated Lake & Canal Co., was chartered in New York on Jan. 11, with the following directors:

Charles A. Pillsbury, of Minneapolis; Bradford C. Church, of Duluth; Elbert A. Young, of St. Paul, Minn.; George H. Raymond and Frank Beadle, of Buffalo; Samuel B. Hard, of Englewood, N. J.; Franklin Edson, John A. Cormack and Erastus Wiman, of New York.

The company has already ordered seven lake steamers and 35 canal consorts, and on Jan. 11 it was granted a 30-year lease of Pier 54 North River for the handling of its freights.

It is a generally admitted fact that even with the improvements now in progress on the Erie Canal, it cannot hold its own against railway competition, if transportation upon it remains in the hands of a multitude of small boat owners. The business of transportation at the present day must be carried on on a large scale in order to be successful; the shipper of goods always prefers to send them over a through line, involving no transfers from one company to the other with the consequent delays. The Consolidated Lake & Canal Co. will be the first organization to control its own lake steamers, canal boats and facilities for transfer at Buffalo and New York. It has agreed with the city of New York to increase the canal traffic by at least 100,000 tons annually, and in a statement before the Dock Commissioners, it was announced that freight would be carried from Buffalo to New York for 45 cts. per ton or 1 mill per ton-mile, while the charge for storage and transfer to ocean steamers would not exceed 25 cts. per ton. With a cost for lake shipments from ports on the upper lakes to Buffalo and of trans-shipment at that port of 50 cts. per ton, the total cost from the grain elevators of Chicago or Duluth to the hold of an ocean steamer in New York harbor would be only $1.20 per ton or less than 4 cts. per bushel. If rates like these are a possibility of the near future—and there appears to be no reason why they may not be reached—the possibility that a ship canal over this same route would be a financial success appears to approach the vanishing point.

The present status of canal transport was well set forth by State Engineer Campbell W. Adams in a recent interview, from which we quote as follows:

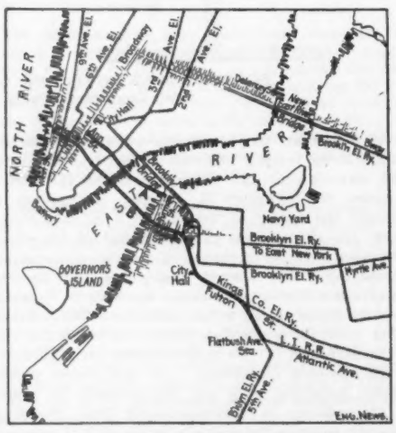
The railroads are doing what every live business organization is doing—taking advantage of all the modern ideas of business. But the canal men expect that their business will keep right up, while they are working along in the same old rut.

A canal transportation company, with offices at New York, Albany, Buffalo and lake cities; collecting agents through the great grain producing districts of the West, who could bill grain from Duluth to Liverpool, just as the railroad companies now do; a company owning its own elevators, store-houses and canal boats—such a corporation would soon double the canal traffic. As it is now, every boatman does business after his own ideas. A man who wishes to send a cargo of grain from Buffalo to New York has to go and look up the boatman at Buffalo, dicker with him over the price, and then be in doubt as to where the cargo will finally land. The canal business should be so arranged that the captain of a grain laden vessel, upon arriving at Buffalo from Duluth, should know precisely what canal boats would be there to take the grain to New York. The railroads to-day own the lake boats, the elevators and some of the canal boats, and the boatman, with his single boat, stands as much chance of successfully competing with the railroads as a single freight train would of competing with the New York Central system.

The report of the Atlantic Ave. Commission, the substance of which is given on another page of this issue, presents a project of very great importance to the inhabitants of New York. Briefly stated, it is proposed to drive a tunnel beneath the East River and extending from a point beneath Cortlandt St. and West St., in New York city, to a point beneath the City Hall, in Brooklyn, and thence to a point beneath the Flatbush Ave. station of the Long Island R. R. The tunnel would be kept at a sufficient depth to be in solid rock all the way from Cortlandt St. to the Brooklyn City Hall, and the cars would, of course, be operated by electricity.

The commission estimates that by such a road the running time from Cortlandt St. to the Brooklyn City Hall could be reduced to four minutes; and by the direct connection which would be given with the Long Island R. R. system, the outlying towns on Long Island and the other suburbs of Brooklyn, would be brought nearer in point of time to downtown New York than Brooklyn itself now is.

As our readers will remember, a private company has recently received a franchise for a tunnel under the East River on a line a few hundred feet north of the one now proposed.




**Proposed Through Lines for Passenger Traffic Between New York and Brooklyn.**

A.—Tunnel Proposed by New York & Brooklyn R. R. Co.
B.—Tunnel Proposed by Atlantic Ave. Commission.

We made some reference in our last issue to the great importance of a thorough system of transport between New York and Long Island. There appears every probability that not only one, but several such through lines will be furnished in the near future. The new East River Bridge now under construction will have accommodations for both elevated and surface street railways. The tunnel projects, above referred to, are favorably received by the public, and at least one of them is likely to be carried out. If, in addition to these the present Brooklyn Bridge should be made available for through traffic, there would then be three avenues for through transit between the two cities.

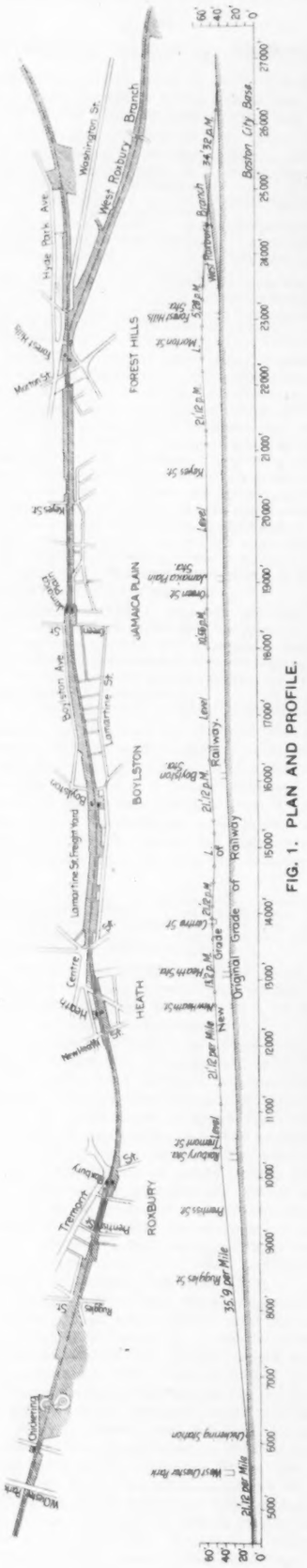
That such a development of the passenger traffic facilities of the Greater New York offers the best solution of the problem of cheaply and comfortably housing the great bulk of its population, must be the conclusion of any one who gives careful study to the subject.

The compound locomotive is now almost universally admitted to possess economical advantages over simple engines in the matters of fuel consumption and water evaporation, but there is still a considerable amount of prejudice against it and some objections still continue to be put forward. One of these objections is in regard to the increased cost of repairs of the compound engine, by reason of its greater number of working parts, although this has been many times shown to be much less important than is usually claimed by the objectors. The only really practical comparison as to the comparative efficiency and economy of the simple and compound engines is that based upon the service performance of engines alike in all respects except the compounding, running in the same service on the same divisions, and for a sufficient length of time to show a reasonable average, thus eliminating the actual records of specially good or bad performances. In another column we present a number of comparisons of records of this kind, for simple engines and two-cylinder compound engines, and these show a decided uniformity in the advantages of the latter type. In one record attention is called to the prejudices of the men on the road, and it is shown that the prejudged failure for the engines was overwhelmed by their practical success. It is also shown that expenses for repairs may be sometimes less and sometimes more for the compounds than for the simple engines, and that in any case, the increase is not enough to offset the other advantages. Of course, with three or more cylinders, and a corresponding increase in number of working parts, a greater increase in repairs may be expected. However this may be, the concise official statements above referred to go to show very conclusively that the two-cylinder compound locomotive possesses decided advantages over simple engines of similar construction, both in freight and passenger service.

The prevention of accidents on street railways is discussed at considerable length in the report which has just been issued by the New York Railroad Commission. With regard to the overcrowding and the excessive speeds of cars, it is shown that there is not only disregard of city ordinances regulating the number of passengers to be permitted on a car, but also neglect of ordinary precautions, and gross carelessness on the part of employees. In one instance that was investigated this overcrowding was found to be the chief cause of an accident which resulted in the killing of two passengers and the injury of several others, and this overcrowding was a common practice on this line, particularly on Sundays. The Commission believes that overcrowding can only be prevented by legislation providing a severe penalty for permitting a greater number of persons to ride on the car than can be conveniently seated and stand in the aisles. The agitation calling for the use of fenders has somewhat subsided, and the Board believes this is because a thoroughly efficient fender is not yet developed. It suggests, however, that the general use of fenders should be provided for by legislation. The compulsory heating of cars is also suggested as a matter proper for legislation. Experiments in power brakes are said to be still progressing, and though some electric and air brakes have been experimented with and abandoned, it is predicted that power brakes will in the near future be used on all mechanically operated cars in large cities. It does not seem to us, however, that the present status of the street car brake question warrants any such prediction.

### THE COST OF AMERICAN ARMOR PLATE.

When the appropriations were made for the naval service, for the fiscal year ending June 30, 1897, Congress directed the Secretary of the Navy to investigate and to report upon the actual cost


Washington St.
West Roxbury Branch
Hyde Park Ave.
Forest Hills
Morton St.
FOREST HILLS
Boston City Bdry.
West Roxbury Branch
Forest Hills Sta.
Level
Hayes St.
Boston Ave.
Lamartine St.
JAMAICA PLAIN
Jamaica Plain Sta.
Level
Railway.
Boylston
BOYLSTON
Boylston Sta.
Level
Lamartine St. Freight Yard
Centre
Heath St.
HEATH
Heath Sta.
Original Grade of Railway
New
Level
Tremont
Bdry.
Tremont St.
Bdry.
Eliot
ROXBURY
Eliot Sta.
Level
Roxbury
Parmenter St.
Parmenter
Bdry.
Eagles
Chickering
Dedham Branch
Clickering Station
West Chester Park
21/2 per Mile
35.9 per Mile
21/2 per Mile
21/2 per Mile
Grade
Grade
Grade

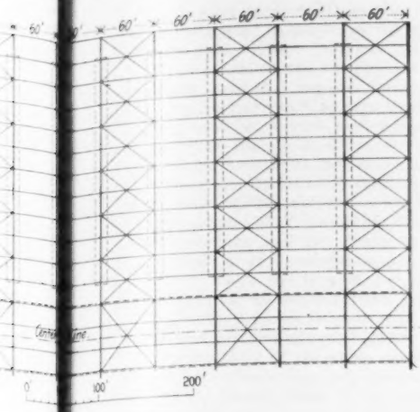



FIG. 5. ALF PLAN OF ROOF.

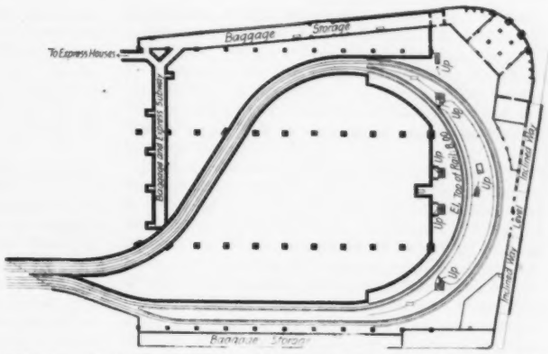



FIG. 3. PLAN OF LOWER FLOOR OF STATION, SHOWING LOOP TERMINAL FOR SUBURBAN TRAINS.

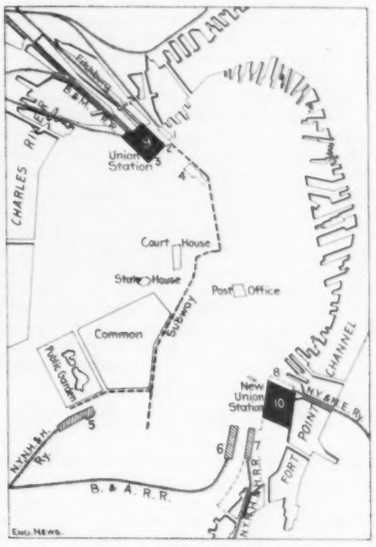



FIG. 1. MAP SHOWING TERMINAL STATIONS AT BOSTON, MASS.

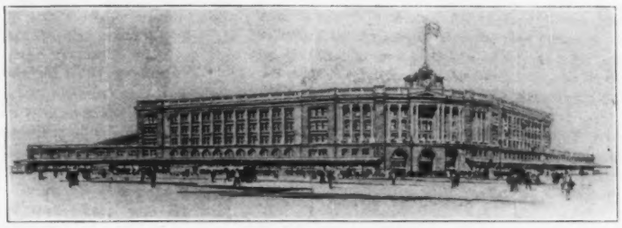


FIG. 6. PERSPECTIVE VIEW OF STATION.
Shepley, Rutan & Coolidge, Architects.

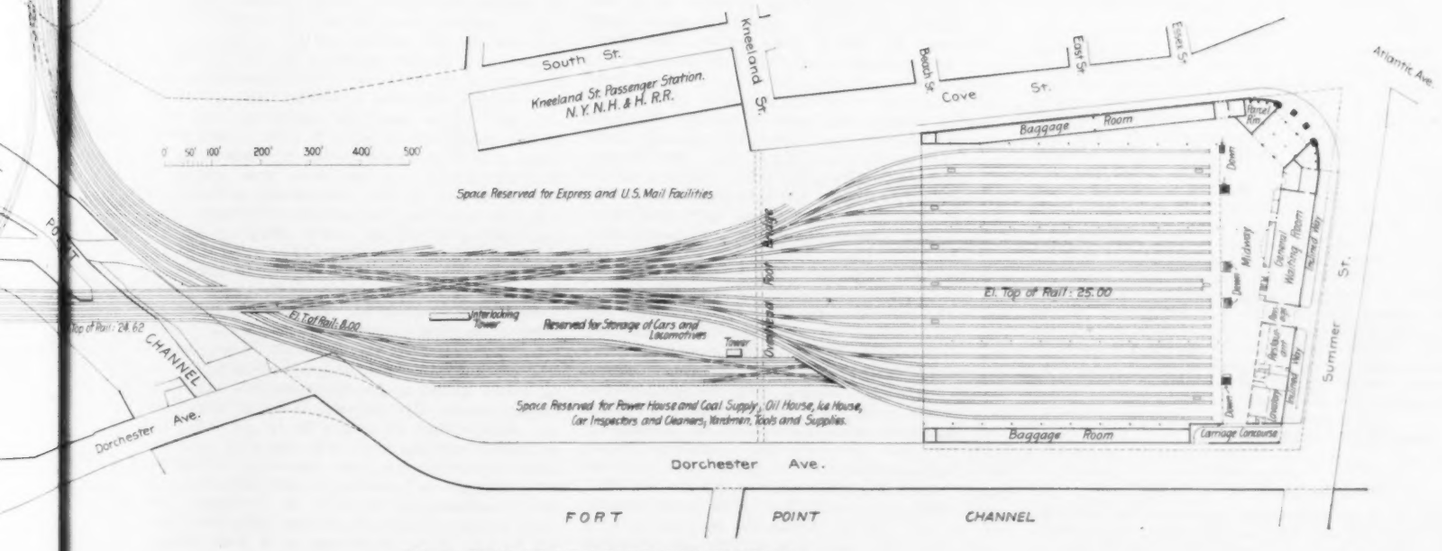



FIG. 2. PLAN OF NEW SOUTHERN TERMINAL.

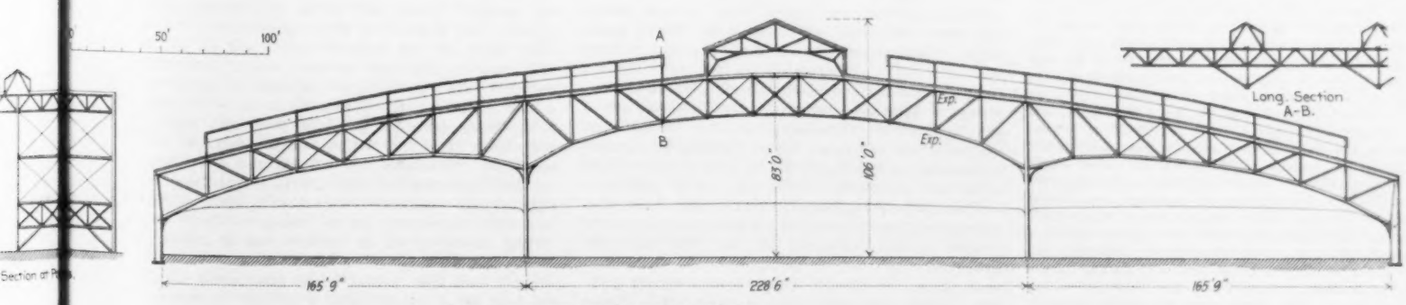



FIG. 4. SECTIONS OF TRAIN SHED.

## NEW SOUTHERN RAILWAY TERMINAL FOR BOSTON, MASS.

Boston Terminal Co.

Geo. B. Francis, Resident Engineer.

John C. Sanborn, Manager.

of making armor-plate in this country, and also to state what would be an equitable price per ton to be paid for such American armor. This resolution was called out by the charge made in the public press that our government was paying too much for its armor, as compared with the cost of that used by foreign governments, and that the American makers of armor were receiving an exorbitant profit upon the plate which they supplied.

Secretary Herbert has therefore made an investigation of this subject, with the assistance of Commodore W. T. Sampson, Chief of the Bureau of Ordnance, and Mr. Philip Hichborn, Chief of the Bureau of Construction and Repairs. In the report which the Secretary last week submitted to Congress he estimates the average actual cost of making a ton of single-forged, nickel-steel, Harveyized armor-plate at $184.38; and the cost of reforged plate of the same description at $197.78 per ton. Concerning the proposal that the government should make its own armor, the Secretary says that a recent estimate for an armor-making plant, in France, was $700,000; and that a similar plant erected in this country would probably cost $1,400,000. An English estimate for an armor plant of equal capacity with that of the Carnegie Steel Co. amounted to $1,590,000.

But in discussing what is an equitable price for the product of American armor-makers, Secretary Herbert takes a broader view of the subject than the average objector to the present prices. He points out the fact that the builders of these plants assumed heavy risks, as the government was the only purchaser and there was at first little assurance of the continuance of a considerable demand for the product. For these reasons the profits were necessarily made large. Further than this, the government created these plants, and it is good public policy, says Mr. Herbert, to perpetuate them, in order to enable the country to be independent in this important matter of national defence. In his opinion the government should pay for all its future armor purchases a price sufficiently liberal to justify the contractors in keeping their plants in first-class condition to meet any emergency that may arise. He concludes that in view of these circumstances and of the uncertainty of future contracts, that a profit of 50 per cent. upon the cost of manufacture would not be inequitable; and, by adding various items which he considers just, he brings the price per ton to $400, which he deems a fair and equitable price to pay for the armor of the newly authorized battleships.

It is of interest in this connection to turn back ten years and examine the discussion on armor-plate in the report by Secretary Whitney in 1886. In that report the Secretary said that the small amount of modern armor then used upon our new ships was purchased abroad, a policy which he designated as not in keeping with proper dignity and pride, nor at all consistent with wisdom. It was about this time that Congress, after discussing the matter for several years, concluded that it was wise to declare that all guns and armor thereafter used should be of domestic manufacture; provided, that these could be furnished within a "reasonable time, at a reasonable price, and of the required quality." To induce steel manufacturers to undertake the necessary expenditure for the plant required to make the heavy forgings for armor, Congress specially authorized the combining of all the armor required for the ships then authorized in one contract, and this contract was submitted to general competition. Mr. Whitney regarded it as a lamentable circumstance that a country like ours, with its immense products of iron and steel, should be content to be dependent upon other nations for the fabrication of armor and high-power guns, both indispensable and essential parts of a modern warship. He thought that whatever might be the commercial policy of a nation, in the creation of its necessary implements of war it should certainly be independent. At the same time Mr. Whitney said that the experience of the Navy Department in its first attempt at the creation of modern vessels of war had been such "as to excite the greatest concern and disappointment," and in that year the department commenced to purchase English plans, as the "best means then available for securing the speed and design required." The Senate Committee on Ordnance and Warships, for 1886, also noted that, at that time, "no navy yard and no private establishment in the country had the plant for forging all the parts of a steel gun above the caliber of 6 inches," and all the heavy parts of the few large guns then being made were supplied by English manufacturers.

Within ten years all this has been very radically changed, by the formal decision of Congress to create and, by implication at least, to encourage the domestic manufacture of armor and heavy guns. Under the inducements held out, several large steel-making concerns expended millions in establishing suitable plants, and American inventive genius at once went to work, improving upon the methods of other countries, and inventing new armor-making processes. Our Navy Department is now no longer purchasing plans for warships from foreign nations, but has designed and built ships that are serving as models to the older countries; our 13-in. guns are the largest now used on modern battleships, and the American Harvey process for armor-plate has been adopted by England, France and Russia. In fact, as designers and builders of guns and warships, we at least rank with the best in the world, and we now have both steel plants and shipyards with a capacity equal to all demands.

No one will deny the wisdom of expending among our own people the millions appropriated in these ten years for war material, rather than sending these same millions abroad. But it is also undeniable that without some such action as that taken by Congress in 1886, we would either be purchasing our ships and guns from foreign nations, or be without a modern navy and the means of national defence. We have good reason now to be proud of American warships and their equipment in all respects; and as one result, the United States occupies a higher position in the respect of Continental nations than it did ten years ago. Having made this new departure, it seems to be good public policy to support the new industry and to keep it in a condition to meet all future demands. As the national government is practically the only purchaser of armor and guns, this support must come in a fair and liberal price paid for the product; for, from abundant experience, it is to be assumed that the desired end would not be as well or as economically reached by the establishment of a single government armor-making plant.

As to the price which, will effect this end, the government paid an average of $650 per ton for the 20,000 tons originally contracted for by Secretary Whitney. It is stated that the two steel companies which made the first armor expended about $3,500,000 upon the construction of their plants. With the uncertainty of further orders that then existed, and considering the trials and failures necessarily following an entirely new enterprise, the price may not have been excessive. In 1893, another lot of 7,000 tons of armor was contracted for at prices varying from $520 to $885 per ton, the latter price being paid for special plates. But in the meantime the Harvey treatment had been introduced nickel-steel was adopted, and the ballistic requirements were made much more severe. Now comes another lot of armor for the three battleships lately authorized by Congress, and the present controversy is as to "an equitable" price per ton to be paid for the same.

Even under all the difficulties and expense incident to the establishment of the new industry it is safe to conclude that a considerable portion of the original investment in the plant has now been repaid to the owners, and it would not be reasonable to adhere to the old prices. Secretary Herbert's estimate of an equitable average price is $400 per ton. This is certainly liberal; for on an estimate of slightly less than $200 per ton for actual cost of manufacture, it allows a profit of 100 per cent. But other things were doubtless considered by the Secretary of the Navy in arriving at this figure. The cost of maintaining such a plant in good condition is very heavy, and is, of course, a legitimate part of the cost of production; the nickel, previously furnished by the government and adding $20 per ton to the cost per ton of the armor, is now to be supplied by the contractor, and the requirements for excellence are more severe than ever. In every respect the armor supplied is to be better than that made to meet the order of 1886. These points have doubtless been duly weighed by the Secretary of the Navy, from full information, and his price, large as it is, is probably fair.

Armor is not a commercial article, in the sense of obtaining it in an open market, for without special and large inducements no corporation could enter into competition, and Congress has declared it as good public policy not to purchase from foreign makers. Two well-equipped establishments have already been created in this country by offering these inducements, and these two are enough to meet all probable demands. We do not want more, but we should keep these two up to the highest standard of efficiency—even if it does cost $400 per ton to do it.

## LETTERS TO THE EDITOR.

### Distances on the "Monongahela Navigation" Canal.

Sir: In your issue of Jan. 7, in "The History of the Monongahela Navigation Co.," I notice discrepancies in the distances given. Thinking that it may be of interest to some of your readers to know the correct distances I append the following, which shows the distance to the Virginia (now West Virginia) line to be much greater than your article gives:

Pittsburg Landing, O., Dam No. 1, 1 mile; Dam No. 2, 12 miles; McKeesport, 16 miles; Dam No. 3, 25 miles; Monongahela City, 32 miles; Dam No. 4, 41 miles; Brownsville, 57 miles; Dam No. 5, 59 miles; Dam No. 6, 71 miles; Dam No. 7, 87 miles; Dam No. 8, 91 miles; W. Virginia line, 96½ miles; Dam No. 9, 97 miles; Morgantown (present head of navigation), 105 miles. A. Onderdonk.

Hagerstown, Md., Jan. 8, 1897.

### The Relation Between the Meter and the Foot.

Sir: The writer recently made some comparison between the hectare, the customary unit for land measurement with the metric system, and the square mile, and was surprised to find that the relation could be expressed in whole numbers with the greatest exactness. The relation is: 259 hectares = 1 sq. mile. From this equation, using ten place logarithms, the logarithm is ascertained, to reduce meters to feet, 0.5150840405.

On page 280 of the U. S. Coast and Geodetic Survey Report for 1894, it is stated that "the value adopted (Nov., 1891) by the U. S. Office of Standard Weights and Measures is, one meter = 39.37 ins, which agrees with the legal value adopted by the United States." From this is derived the relation, one meter = 3.2808333 + feet, the corresponding logarithm being 0.5150842, differing from the above ascertained value by 1.6 in terms of the seventh decimal place, a difference corresponding to 1-60,000 part of an inch in a meter, or 1-2,720,000 part of the meter, a quantity too small to be considered.

Hence the relation, as expressed in whole numbers, may be regarded as an exact one, and the value of 259 hectares = 1 sq. mile will answer all possible requirements in area or lineal comparisons. Very truly yours,

Horace Andrews, City Engineer.

Albany, N. Y., Jan. 7, 1897.

### The Drainage of the Kankakee Marsh.

Sir: The Kankakee River Improvement Co. is the revival of an old project under a newly amended legislative act, and has for its object the reclamation of vast areas of lands in the state of Indiana now subject to almost annual overflow. The Kankakee River (an Indian name signifying crooked) consumes about 300 miles in its tortuous channel to make about 70 miles as "the crow flies." Its fall is less than a foot to the mile in a straight line, but this fall is very evenly distributed. The real head of the river is at Mud Lake, on the line between La Porte and St. Joseph counties, in Indiana. Into this lake empties the drainage of about 300 square miles, having a fall of from 5 to 50 ft. per mile. Grapevine Creek, one of its tributaries, reaches into Michigan in the vicinity of Three Oaks, on the Michigan Central R. R. At least three-quarters of the flood waters come, however, from St. Joseph and Marshall counties through Pine, Potato and Yellowbank Creeks, streams with a rapid fall, which drain a clayey country, and finding but slight fall upon reaching Mud Lake, remain on the marsh for weeks, flooding the whole region. The river banks are almost wholly marsh and are elevated only 1 to 2 ft. above medium low water. The cross-section at right angles with the stream shows from 1 to 4 ft. fall per mile, increasing rapidly as the marsh limit is reached. A peculiarity of the stream is that its channel is comparatively straight, and from 300 to 600 ft. wide, with an average depth of 3½ ft., for some five miles down from Mud Lake or to the vicinity of the Baltimore & Ohio R. R. crossing Then it narrows in to

an average of less than 200 ft., becoming very tortuous and the depth not increasing except in spots where it does no good. These conditions continue some five miles, when it narrows still further to an average width of 100 ft. and less than 50 ft. in places, and becomes so tortuous as to take 4½ miles of the present channel to reach one mile on the proposed improvement. With the exception of Mud Lake, the subsoil is clay, sand and gravel with 1 ft. to 2½ ft. of stiff muck on top. With these general conditions it is proposed to deal as follows: A continuous grade line will be adopted from Mud Lake to below the Pittsburg, Ft. Wayne & Chicago R. R. crossing, depressed 6 ft. below the average bottom of the present channel, regardless of the undulations which may occur in the marsh surface. It is proposed to make the new channel 60 ft. wide on the bottom with slopes of ½ to 1 in clay and 2 to 1 in sand or gravel. A berme of 20 ft. will be left on each side between the top of the slope and the spoil bank for future widening if desired. As a rule the old channel when crossed by the new will only be closed on the down stream side of the crossing. These crossings will occur some 50 times in 15 miles. Thus the old channel will serve as a reservoir for large quantities of flood waters, the cut off segments being all short and the general slight fall of the marsh enabling them to fill from the down stream and up stream without wash. By the above plan the low water level is depressed 6 ft., the length of the stream is decreased to one-third what it is at present, the rate of fall per mile is increased three times, and the narrow, tortuous channel at the lower end is entirely removed. Owing to the slight fall and the character of soil no great difficulty is anticipated from wash. However, it is proposed to keep a plant available to remove any obstructions that may come from this source. Especial attention will be paid in construction to requiring the work to be done to the grade line and removing all possible causes for friction. Changes of alinement will be made with the curves of not less than 5,730 ft. radius.

Many partial drainage failures are traceable to neglect to take the above precautions. All the work so far done is essentially preliminary and as yet no close estimate of cost has been made. The work is in the hands of strong men, long time owners and residents in the region. The assessment plan of raising the necessary funds is adopted and now progressing. If successful the work will be done the coming season. The present channel has a velocity of 88 ft. and a discharge of 22,100 cu. ft. per minute. The new channel will have a velocity of 242 ft. and a discharge of 157,170 cu. ft. per minute. Both these estimates are based upon the channels being bank full. Our farmer friends—and many others in the business world, are subject to the same criticism—are loth to give the engineer his proper place in best adapting nature's forces to the uses of man at least cost, but prefer to regard him as the manipulator of some instruments, which have to many of them a mystery about them. But every object lesson we can give them of the cost of work reduced and of better results obtained will raise the profession in their estimation and open a vast field for the future engineer.

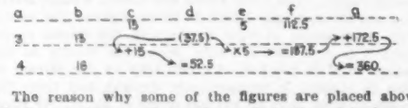
Yours truly, Geo. Crocker,
Chief Engr. Kankakee Riv. Imp. Co.

La Porte, Indiana, Dec. 31, 1896.

(In our issue of Nov. 3, 1892, was given a full illustrated description and editorial discussion of this interesting engineering project, and the plan of Prof. John L. Campbell and that of Mr. W. M. Whitten for carrying out the work were both explained. It was at that time proposed that a system of irrigation for the tract might be combined with the drainage scheme to great advantage. —Ed.)

### A Moment Table for Cooper's Specifications.

Sir:—In your issue of Dec. 10 you publish a letter from Mr. John H. Sayres, giving a moment table for Cooper's 1896 Engine Loadings. The following table prepared in this office, being a modification of one used by Mr. C. L. Strobel, M. Am. Soc. C. E., will be found to have many advantages over Mr. Sayres' table. It is computed for the "Class E-30" loading, and the result can be changed for any one of the other "E" classes given by Cooper, by a single setting of the slide-rule. For example, any moment wanted for "Class E-27" will be obtained by taking 27-30 of the corresponding moment for "Class E-30," given in the table. To prepare this table the computations are exceedingly simple. Each horizontal space refers to a single wheel or increment of train load. To find the moment to the left of any wheel, you add and multiply as shown by the arrows and signs in the illustration:




The reason why some of the figures are placed above the lines is because their only use is in the original computation of the table. All of the figures on the line are used in computing moments and shears. To illustrate how the table is used the following example is given of a 200-ft. span of eight panels:

With wheel 4 at c we have:

| | |
|---|---|
| Length of bridge to right of c | 150 ft. |
| Length of train to left of 4 (from table) | 18 " |
| Total length of train on bridge | 168 ft. |
| Nearest point of train load in table (load 24) | 164 " |
| Distance from load point 24 to end of truss | 4 ft. |
| Total weight of train to point 24 (from table) | 303 Kips. |
| Increment of moment to be added | 1,212 |
| Moment of entire train about point 24 (from table) | 26,238 |
| Increment of moment as above | 1,212 |
| Total moment | 27,450 × 2/8 = 6,862 |
| Negative moment about wheel "4" | 360 |
| Required moments at "c" (thousands of ft.-lbs.) | = 6,502 |

Yours truly,
Pittsburg Testing Laboratory, Ltd.,
T. L. Condron, Resident Engineer.

The Monadnock, Chicago, Ill., Dec. 14, 1896.

| a | b | c | d | e | f | g |
|---|---|---|---|---|---|---|
| No. of Wheel or Load. | Distance from 1st Wheel, ft. | Wheel Loads, Tons. | Sum of Loads, Tons. | Dist. bet. Wheels, ft. | Increment of Moment. | Moment. |
| 1 | 0 | 7.5 | 7.5 | | | 0 |
| 2 | 8 | 15. | 22.5 | 8 | 60. | 60 |
| 3 | 13 | 15. | 37.5 | 5 | 112.50 | 171 |
| 4 | 18 | 15. | 52.5 | 5 | 187.50 | 360 |
| 5 | 23 | 15. | 67.5 | 5 | 262.5 | 623 |
| 6 | 32 | 9.75 | 77.25 | 9 | 607.5 | 1230 |
| 7 | 37 | 9.75 | 87. | 5 | 386.25 | 1616 |
| 8 | 43 | 9.75 | 96.75 | 6 | 522. | 2138 |
| 9 | 48 | 9.75 | 106.50 | 5 | 483.75 | 2622 |
| 10 | 56 | 7.5 | 114. | 8 | 852. | 3474 |
| 11 | 64 | 15. | 129. | 8 | 912. | 4386 |
| 12 | 69 | 15. | 144. | 5 | 645. | 5031 |
| 13 | 74 | 15. | 159. | 5 | 720. | 5751 |
| 14 | 79 | 15. | 174. | 5 | 795. | 6546 |
| 15 | 88 | 9.75 | 183.75 | 9 | 1566. | 8112 |
| 16 | 93 | 9.75 | 193.50 | 5 | 918.75 | 9031 |
| 17 | 99 | 9.75 | 203.25 | 6 | 1161. | 10192 |
| 18 | 104 | 9.75 | 213. | 5 | 1016.25 | 11208 |
| 19 | 114 | 15. | 228. | 10 | 2130. | 13338 |
| 20 | 124 | 15. | 243. | 10 | 2280. | 15618 |
| 21 | 134 | 15. | 258. | 10 | 2430. | 18048 |
| 22 | 144 | 15. | 273. | 10 | 2580. | 20628 |
| 23 | 154 | 15. | 288 | 10 | 2730. | 23358 |
| 24 | 164 | 15. | 303. | 10 | 2880. | 26238 |
| 25 | 174 | 15. | 318. | 10 | 3030. | 29268 |

**Moment Table for Cooper's E-30 Engine Load; Two 106½-ton Locomotives Followed by 3,000 lbs. per lineal feet.**

(Loads in thousands of pounds; Moments in thousands of foot pounds, for one rail.)

### Notes and Queries.

R. E. O'Brien.—Can any of our readers give the address of the widow of the above named engineer, who recently died in New York? He was at one time connected with the Atlantic & Great Western Ry. Co. Answers may be addressed to this office.

E. W. C., of Kaslo, B. C., asks where he can get a set of Ockerson's hand stamps, mentioned in Engineering News Oct. 15, 1896, as being used in the engineering department in Salt Lake City; also the price of same.

The Ockerson hand stamps are made by A. S. Aloe & Co., of St. Louis, Mo., and their cost will depend upon the size and the character of the stamp.

## THE NEW SOUTHERN TERMINAL STATION AT BOSTON, MASS.

(With two-page engraving.)

Within recent years the city of Boston has had no less than eight separate railway terminal stations in simultaneous use, but the consolidation of railway corporations and the desirability of providing improved facilities is leading to the gradual elimination of some of these stations, and when the plans now under consideration are carried out the city will have two large union terminal stations, one on the north side and the other on the south side of the city.

Both the new and the old stations are shown on the accompanying sketch map of the city (Fig. 1). The list of the old stations is as follows: 1, Fitchburg R. R., Causeway St.; 2, Boston & Maine R. R. (Eastern Division), Causeway St.; 3, Boston & Lowell R. R., Causeway St.; 4, Boston & Maine R. R. (Western Division), Haymarket Square; 5, New York, New Haven & Hartford R. R. (Boston & Providence Division), Park Square; 6, Boston & Albany R. R., Kneeland St.; 7, New York, New Haven & Hartford R. R. (Old Colony System), Kneeland St.; 8, New York & New England R. R., Federal St. Of these Nos. 1, 4 and 8 have been abandoned. The union station, No. 9, occupies the site of Nos. 2 and 3, and takes all the traffic formerly using Nos. 1, 2, 3, and 4. The New England R. R. traffic, since the lease of that road by the N. Y., N. H. & H. R. R., has been transferred to the Kneeland St. station, No. 7, of the latter road.

It is now proposed to rearrange the terminals at the southern end of the city, and the Boston Terminal Co. has been authorized by the legislature to establish a great terminal, shown at No. 10, which will take all the traffic now accommodated by Nos. 5, 6 and 7, and these three will then be abandoned. When this is completed therefore all the railway traffic will be concentrated at the two union stations, marked in black on Fig. 1, and numbered 9 and 10. The first of these has been in operation for some time, and has been described in our columns.

Having thus explained the general situation, we may proceed to consider more in detail the proposed arrangement of the new station, No. 10. The plans have been prepared by the Boston Terminal Co., which is composed of officers of the Boston & Albany R. R. Co. and the New York, New Haven & Hartford R. R. Co. The station will be on Summer St., utilizing the site of the old New York & New England R. R., and beyond it will be extensive terminal yards. In all about 40 acres will be occupied, and about 30 acres have been already purchased and paid for. Atlantic Ave. will be abandoned by the city, which will build a new water front street along Fort Point channel, this street being on filled ground with a bulkhead or sea wall.

The general plan of the terminal is shown in Fig. 2, and it will be seen that each of the two railways using the station will have a four-track main line. Fig. 3 is a plan of the lower floor of the station building, which has a loop terminal for suburban traffic, an arrangement which will be described further on.

The bill authorizing the construction of the new southern terminal station was passed by the Massachusetts State legislature in the spring of 1896, and since that time the trustees of the terminal company, in consultation with their engineers and architects, have been engaged in perfecting the scheme. Many different plans and methods of operation were considered, and the advantages of each have been incorporated in the adopted plans as far as possible. Some important changes have been made in the arrangement of tracks and platforms since the preliminary plans were prepared last spring, and these changes have greatly increased the train capacity of the terminal. At that time the problem was to show the adaptability of the locality for station purposes, but when the general court had recognized that point the problem changed to that of the best and most economical development of the territory thus made available. Continued study by the engineers (both at home and abroad), together with the recent advances in the development of electricity as a motive power, have made it possible to now present features which a few years ago would have been altogether out of the question.

It has long been recognized that the suburban, or commutation, passenger traffic of the steam railway is different in character from the main line passenger traffic, or that which goes beyond the commutation points, or points of local traffic from the main terminal. The city of Boston is

noted for the number of its suburbs and the great extent of its suburban traffic, radiating in all directions from the city. The great extent and probable steady increase of this traffic therefore made it most important that special attention should be paid in designing the terminal to afford the best possible accommodation for the present and future traffic of this character. For some time past the New York, New Haven & Hartford R. R. has been experimenting with electric traction, with a view to adopting this for its suburban traffic (running on the same tracks as the main line trains hauled by steam locomotives). As it was considered probable that this system will be in operation by the time the station is completed, provision has been made for handling the main line and suburban trains independently of one another in the station, and it has been assumed that the latter will be handled by electricity or some motive power free from steam, gas and smoke.

At the present stations whose traffic will be taken by the new station, about 25 tracks are used for passenger service, and those are even now overtaxed. The largest number of stub tracks proposed in the new station was 31, or very little more than the number needed as soon as the station should be ready. The question then was what greater accommodation could be provided later on when electricity or some other simple motive power may be in use, and the commutation train service may be largely increased. Even now the number of the commutation trains is about 66% of the total number of trains. The additional facilities could not well be obtained by simply securing a greater area of land and having more stub tracks, on account of the complication of the switches and track conections. These connections at the point where the station tracks branch out from the main tracks, are generally so congested, after serving twenty or more tracks, that the number of necessary crossing movements limits the further development for economically handling the traffic. At the present southern and western stations there are in the neighborhood of 3,800 switch movements through these switch systems in a day of 18 hours. As arranged, the steam railway stub track terminal station is left as usual with the platforms 5 ft. above the street grade, but with all the platforms reached without the use of any steps whatever.

A radical departure from former precedents has been made by providing for tracks upon two floor levels instead of one, as first contemplated. The upper level will be devoted to the usual steam railway stub track terminal station for the main line, or through trains, which go beyond commutation points, and also for such suburban trains as it may be desirable to keep on that level. The lower level will be used exclusively for suburban trains which may be run by electricity or any other motive power which avoids the nuisance and difficulty incident to smoke, steam and gas. The upper floor will have the platforms 5 ft. above the street level, but will be reached by an easy incline, without any steps. This upper floor will be provided with 28 stub tracks. These will be so arranged in connection with the switches which connect these tracks with the main line tracks of each road, that all outgoing trains may leave from one side of the trainshed, and all incoming trains enter on the other side of the trainshed, or if desired the trainshed may be divided into two grand divisions, one of which shall be used by the roads going out westerly, and the other by the roads which go southerly over the Fort Point channel. The former are the Boston & Albany R. R. and the Providence division of the New York, New Haven & Hartford R. R. The latter are the New England R. R. and the Plymouth division of the N. Y., N. H. & H. R. R.

The 28 tracks will hold about 350 passenger cars when completely filled. There will be seven platforms, the entire length of the stub tracks, devoted exclusively to the trucking of baggage and express matter, altogether out of the way of the passengers, and at the end of these trucking platforms there will be baggage and express truck lifts to a subway under the tracks connecting with the baggage-room and the express buildings.

The lower floor will have two loops, or circulating tracks, which connect with the main tracks at points about half a mile from the station, the connecting curves and grades being suited to the light nature of the rolling stock required for suburban business. By this arrangement the capacity of the area occupied by the station has been greatly increased, and the frequent service of suburban trains is quite independent of and does not interfere with the less frequent service of the main line trains. It also distributes the passengers over a greater area, thus reducing crowding or inconvenience.

It has long been recognized that the ideal way to handle passenger trains at a busy terminal was to do it by a loop track, or tracks, so that all switching may be eliminated and trains kept moving in the same direction. So far, however, no station grounds have been large enough for loop tracks of curvature suited to steam locomotives, but, in view of the use of electric traction, this system has become feasible for the handling of the suburban traffic in this new station. The plan shown on Fig. 3 was not adopted until the subject had been fully canvassed.

The loop system was adopted for the above reasons for the suburban class of trains, which at present outnumber the other class two to one, and, which, with the adoption of electric traction and a still more frequent service, will in all likelihood outnumber them six to one, and thus allows one train to follow another in rapid succession. The radius and head room of the loop track is large enough for the use of just such cars as are now run on suburban trains or such improved equipment as may be devised. The loop does away with a large proportion of the switching and reduces the probability of congestion in the yards.

The loop tracks enter the trainhouse at one side of the steam tracks, and at a grade about 17 ft. beneath them, and as they enter they spread to pass on either side of a large island platform between the tracks. This is designed to be the loading platform, so that outgoing passengers are upon the right platform for every suburban train using the station. The two outside platforms will be for unloading the passengers from incoming trains. These platforms are of such length that 14 trains of three cars each may stand next to them, seven on each track. It is stated that when it becomes necessary to send out one train a minute it can be done, and then each train will remain in the station four or more minutes for unloading and loading. This means upwards of 2,000 trains in and out in each day of 18 hours upon these two tracks alone, which is five times as many as are at present run in the suburban service. The platform area devoted to this service will allow an assembling of about 25,000 people at one time.

These two floor levels are about equal in vertical distance above and below the level of Summer St., and all passengers may go to and from the street without the use of stairs to either floor just so long as the forward loop platform is used to load and unload passengers upon, which may or may not be the case in actual operation.

When it becomes necessary, by growth of the traffic, to use both loop tracks, the loading will probably be done from the platform between tracks, and even then the passengers will have to go downstairs (not up), to get to their trains. The proposed raised platform will greatly lessen the height of the stairways required.

The head house will contain offices for all the railways entering the station, and is thus left exactly as if there were no loop tracks, or tracks on two floors. As shown by the cross-sections in Fig. 4, the trainshed will be in three spans, with a roof of one sweep, which, together with the roofs over the baggage-rooms on the two sides, will make a roof area about 700 ft. long and 650 ft. wide, which will be the largest railway building roof in the world. Fig. 5 is a half plan of the roof showing the diagonal bracing. The station as a whole, when completed, will have a capacity far in excess of any other in the world, and will be the first one in which any other motive power than steam has been recognized, and where such a large development of the land has been effected.

There will be offices for the large and local express companies, and ample provision will be made for the loading and unloading of mail in bulk.

The switch system will be governed by towermen through the pneumatic system of interlocking. The power plant for the whole terminal will be a large one and will be located on the Dorchester Ave. side.

The general appearance of the station building is shown in Fig. 6. The corner of the building at the junction of Summer and Cove Sts.,will be built on the arc of a circle for a distance of 228 ft., and here will be the main entrance, 92 ft. in width, facing directly up Federal St. At the top of the building, and over this entrance will be a clock 14 ft. in diameter, and at a height of 100 ft. above the sidewalk. On either side of this curved portion, the main building will extend 324 ft. on Summer St., and 324 ft. on Cove St. Beyond the main building, on Cove St., the baggage-room will extend 350 ft. to the end of the trainshed. On Summer St., beyond the main building, a two-story building will extend to the corner of Dorchester Ave. The whole Dorchester Ave. front will be occupied by a two-story building, the first story being devoted to a carriage concourse and baggage-room; the second story to rooms for conductors, trainmen, stores, etc. On Summer St. the building will be set back 20 ft. from the lot line to allow for two inclined sidewalks down to the suburban trains. These inclined ways and the sidewalk next Summer St. will be covered by an awning of glass and metal, projecting beyong the curb line over the street. The first story and basement will be devoted entirely to railway purposes, and the second story to offices of the terminal company, general offices and restaurant rooms in addition to those provided on the first story. The third, fourth and fifth stories will be occupied by the offices of the several railway companies forming the terminal company. In addition to the main entrance, access to the trains on the upper level will be provided from Cove St., Summer St. and Dorcester Ave. The passage on the Summer St. side will be 44 ft. wide, while that on Cove St., will be 25 ft. wide The carriage concourse, 36 × 180 ft., is to be on the corner of Summer St. and Dorcester Ave.

To the left from the main entrance on Summer St. and almost in the center, at the head of the tracks, will be the general waiting-room, 65 × 225 ft. This extends up two stories, being about 28 ft. high to the upper side of the ceiling beams, these beams being 4 ft. deep. This room is entered by two vestibules from the Midway, and one end opens into the pasage from Summer St. The ticket office, 12 × 92 ft., will have 24 ticket windows, and will extend along the side of the waiting-room between the two vestibules, giving direct access to the trainshed as well as to the waiting-room.

The remainder of the space on the side will be taken up by a bureau of information, telephone and telegraph offices, and an entrance to a stairway to the suburban trains below. At the end of the waiting-room, near the main entrance, will be a women's room, 22 × 34½ ft., with a lavatory 40 × 40 ft. In the corner there will also be a men's lavatory opening from the Midway through a vestibule. On the side of passage leading out on Summer St., and across from the general waiting-room will be a restaurant, 68 × 73 ft., a portion of this space being devoted to a lunch counter. A private dining-room will be on the second story. In connection with these are the necessary serving-rooms, etc., the kitchen and bakery being on the second floor. There will also be a barber shop, 34 × 42½ ft.,provided with bathrooms on a gallery,and bootblack room in close connection; a stationmaster's room; smoking-room, 37 × 60 ft., with men's

lavatory, 30 × 72 ft., and a carriage office and cabmen's room.

The two baggage-rooms flank the trainshed on both Dorchester Ave. and Cove St., extending well up to the front of the station. Lifts are provided for the carrying of baggage from the first floor to the basement. Off the passage from Cove St. is the entrance to offices on the upper floors, being provided with three elevators and a stairway.

The space between this and the main entrance forms a large parcel-room, 42 × 64 ft., easy of access from all sides. In the Midway are located stairways going down to the suburban trains. The stands for newspapers, soda water, cigars,etc., will be conveniently situated in the Midway. At the further extremities of the low buildings on both Dorchester Ave. and Cove St. are additional entrances to offices on the second floor. In the basement are provided ample facilities for accommodating the suburban traffic, there being extensive platforms leading to stairways up to the Midway and inclines to the outside. A ticket office will be provided on the outward platform. Provision has also been made for an immigrant waiting-room with necessary lavatory. The space remaining will be used entirely for baggage, being connected by subways with lifts between tracks as well as lifts from the baggage-room above. The Midway averages over 100 ft. wide for about 600 ft. of its length.

The officers of the Boston Terminal Co. are as follows: Chairman of the Board of Trustees, Charles P. Clark (President, N. Y., N. H. & H. R. R.); Vice-Chairman, Samuel Hoar (General Counsel, Boston & Albany R. R.); Trustees: Chas. L. Lovering, Francis L. Higginson, and Royal C. Taft; Manager, John C. Sanborn; Resident Engineer, George B. Francis, M. Am. Soc. C. E.; Treasurer, Charles F. Conn; Clerk, James W. Perkins. The engineering features of the plan were developed by Mr. Francis, in consultation with the chief engineers of the roads which will use the terminal, and under the supervision of the Board of Trustees and the Manager. The architects of the station building are Shepley, Rutan & Coolidge, of Boston. We are indebted to Mr. Francis for the plans and information used in the preparation of this article.

## ALUM FEEDER FOR THE MECHANICAL WATER FILTRATION PLANT AT LEXINGTON, KY.

One of the essentials to the proper operation of a mechanical filter, where alum is used, is some device to maintain a constant relation between the alum dose and the amount of water treated. If the rate of filtration could always be kept uniform the problem would be very simple, but in some plants there are great fluctuations in the rate, and in nearly all there is no little variation.

The alum feeding device in use at Lexington, Ky., is shown by the accompanying illustrations. Fig. 1 is an elevation of the alum tanks and force pump supplying the alum solution receiver, and Fig. 2 shows the alum injector, which takes the solution from the receiver and introduces it into the water main leading to the filters. We understand that this device has been developed by Mr. S. A. Charles, for many years Engineer and Superintendent, and now Receiver, of the Lexington Hydraulic & Manufacturing Co., which supplies Lexington with water. We are indebted to Mr. Charles for the blue print from which the illustrations were prepared, and also for the following description of the device:

Side by side are two wooden tanks, shown by Fig. 1, of 320 gallons capacity each, connected with 1½-in. suction pipes to a duplex pump (size 2¾ × 4 × 4). These tanks are used, one as a day tank from 6 a. m. to 6 p. m., and the other as a night tank from 6 p. m. to 6 a. m. The tanks are charged with the necessary amount of alum as soon as they are emptied, which charge is varied in amount from time to time to suit the condition of the water. This gives twelve hours time to dissolve the alum before use, which is done with the tank one-third full of warm water. When a tank is started in service it is then completely filled and thoroughly stirred up; then the suction valve is opened and the tank is ready for service.

The pump discharges into a 40-gallon iron closed tank or receiver, in which a pressure is maintained sufficient to empty the alum tank in twelve hours. The pressure is regulated to vary with the consumption of water and consequent change of speed of the low service pump supplying the filters. The regulation of pressure is accomplished by using a relief valve on top of the receiver, which is set to give any desired pressure, and which relief is constantly discharging into the bottom of the alum tank in use. In addition to carrying a uniform pressure after once set, it also keeps the solution of alum in constant agitation, thereby giving better results than could be obtained by occasional stirring.

The supply to the automatic feeder, or injector, is taken from the receiver and is fed from the injector with each stroke of the low service pump to the main or pipe discharging into the filters. The feeder or injector, Fig. 2, is constructed with poppet valves and consists of two ½-in. check valves that are made with stems like a globe valve; the valves are operated by an oscillating beam motion, taken from the rock shaft of the low service pump, and are seated by springs on the stems. Both valves have the pressure at all times on the seat and therefore can not catch up. As the piston makes a stroke, the beam swings and catches the trip in the stem of the inlet valve and raises it. Then as the piston makes a return stroke it releases the trip and the spring seats the inlet valve. As the stroke is continued the outlet valve is opened and the charge of solution is discharged into the force main. The discharge is caused by compression, the pressure on the solution-feeder being from 30 to 50 lbs., and on the force main, 8 lbs. The amount discharged cannot vary and is the same to each and every stroke, only as this amount is varied by changing the pressure on the relief valve to suit the consumption, this in turn being met by putting an increased amount of alum in the tank. There are no valves to adjust, feeds to set or any other adjustments to make to give positive results. All that is required when starting a tank in service is to open the suction valve on the tank emptied. The balance of the feed takes care of itself with no attention whatever, and ten minutes is all the time required to change from one tank to the other and charge the empty tank.

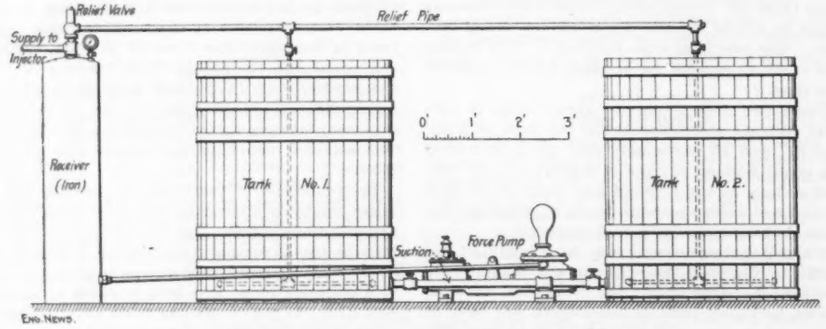



FIG. 1.—ALUM TANKS, PUMP AND RECEIVER AT LEXINGTON, KY.

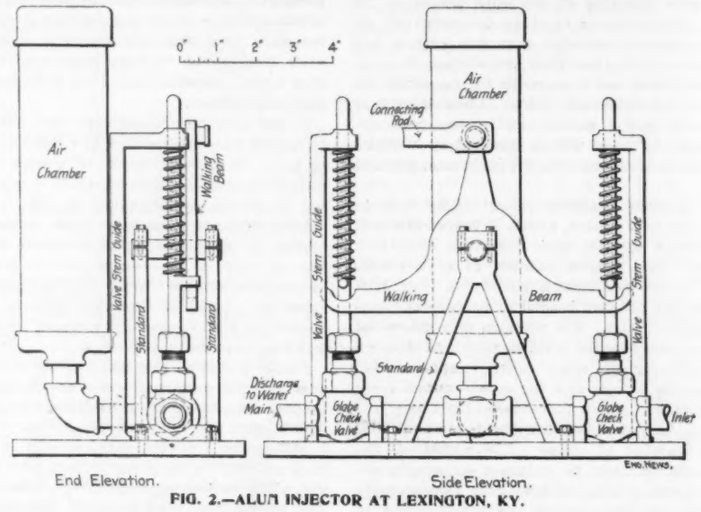



FIG. 2.—ALUM INJECTOR AT LEXINGTON, KY.

The Morison-Jewell filters in use at Lexington were described in our issue of May 28, 1896. The alum feeder used in connection with the Warren filter was described in Engineering News of Jan. 4, 1894.

## COMPRESSED AIR AND ELECTRIC TRACTION ON NEW YORK STREET RAILWAYS.

The underground trolley system of electric propulsion for street surface roads has now had a year's trial on the Lenox Ave. line of the Metropolitan St. Ry. Co. in New York city, and although not quite as satisfactory or economical as the overhead trolley, is regarded as preferable to the cable in so many respects that its use is to be extended to other longitudinal routes of this company. In view of this fact it is safe to predict that there will be no more cable construction in New York city.

Some very satisfactory experiments have been made recently with compressed air as a motive power. Three Hardy compressed air cars, manufactured at Rome, N. Y., have been in operation on the 125th St. line of the Third Ave. R. R. Co. since Aug. 1, 1896. The cars are run across 125th St. from the Fort Lee ferry to the East River, a distance of a little over two miles. They are charged every three round trips, thus giving them a run of about 13 miles. The heaviest grade is about 8%, near Fourth Ave. The compressor plant is located at the car barn. An 80-HP. engine compresses the air into a battery of storage tubes at 2,000 lbs. pressure, and the air is carried through a pipe to a point in the barn where the car is charged, about two minutes being required for the operation. Two cars are constantly in service. The third stands at the barn ready to take the place of a car requiring to be recharged. Each car holds 52 cu. ft. of air under a pressure of 2,000 lbs. The working air pressure as applied to the motor averages about 130 lbs. During the December snow storms the cable cars were blocked on the 125th St. line while the air cars had no difficulty in making time when not interfered with by the other cars. It is claimed by the inventor of this system that the cost of operation per car mile will be less than the overhead trolley system. The limited operation on 125th St., however, does not furnish sufficient data for accurate conclusions.

The Hoadley compressed air system is being experimented with by the Metropolitan St. Ry. Co. on its Lenox Ave. line between 110th and 146th St. with apparent success. The chief difference between these two compressed air systems is in the method of applying the power. The Hardy motor has cylinders and piston acting di-

*Extract from the report of the Board of Railroad Commissioners of New York State for 1896.

rectly upon the axle as in the case of a steam locomotive. In the Hoadley motor the power is applied by gearing.

The Manhattan Elevated R. R. Co. intends making experiments with the Hardy motor. The motor company is now building an engine at Rome about the size of the steam engines at present in use on the elevated railway. It will be operated on the Sixth Ave. line, between Rector St. and 58th St., the compressor plant being located at Rector St. The engine will be constructed to carry sufficient air to operate a train of five cars 13 miles without recharging. It is expected that the engine will be ready for service some time in February.

The elevated railway company has also been trying electricity on its 34th St. branch, from Third Ave. to the 34th St. ferry. The motor was built upon the trucks of a dummy engine. A third rail, which conducts the current from the power house to the motor, has been placed on insulated chairs fastened to the guard timbers outside the track rail and standing about 10 ins. above the track rails. The connection is made by two steel shoes which reach from the lower side of the motor and clasp the charged rail. When more electricity is produced than is used by the motors it is stored in accumulators located at the ferry end of the route. This motor has been successfully working since Oct. 5. The average power, including heat and light for the cars, is 45 amperes; voltage 450. No difficulty in operation was experienced during snow storms, and mechanically the motor has done all the work required of it. Regarding its economical efficiency, the line is too short and the traffic too limited to admit of comparisons that would be of much value.

## NOTES OF A TRANSCONTINENTAL TRIP.

### VIII.

Canadian Pacific Ry.; Vancouver to Montreal.

On July 28 I left Vancouver on the transcontinental express for Montreal, this train having a through run of 2,906 miles, occupying 125 hours, or an average running speed of 23.25 miles per hour, including all stops. The train consisted of six cars, and a through sleeping-car from Tacoma was added at Mission Junction. In crossing Pitt River the dikes which protect the land from inundation by floods in the river attract attention. Very soon the line enters the canyon of the Fraser River, and climbs steadily up above the level of that turbulent and muddy stream. The side of the canyon is very precipitous, and the railway is alternately in tunnels and on sidehill banks upheld by masonry retaining walls extending to the level of the track. The tunnels are mostly in hard rock, not requiring to be lined, and they are in some cases fitted with doors at the portals to prevent the snow from drifting in, the doors being closed only during the winter. Some of the steep side-hill cuts are in a loose, dry sliding material, which comes rattling down as the train passes, and these parts of the line require constant watching to keep the track clear. In some places rows of old ties are set on end to hold the stuff back from the track. Many wooden trestles have been filled or replaced by iron structures. The remaining wooden structures are mainly in good condition, except that a number of them are defective as to guard rails, which are loose and decayed, but new floors have the guard timbers faced with iron. At North Bend there is a stop for supper at the company's hotel, and there is an entire absence of rush and hurry over the meal, so that passengers can eat in comfort, an unusual feature which does not fail to bring forth numerous favorable comments. The old government road (abandoned since the opening of the railway) is plainly visible on the opposite side of the gorge, and during the night the wakeful passenger hears a continuous dashing of rapids and falls as the train follows the Thompson Canyon. All along the line the work of filling in trestles is being carried on. Marshes are crossed by banks built upon layers of bush and young trees. The track is mainly of 65-lb. rails with four-bolt joints, though some sections are laid with the standard 72-lb. rail and six-bolt joints. Stub switches and rigid frogs are used. Some of the main line switches have an extra switch rod with two slots fitted over a stud on the base of the switchstand. This rod holds or locks the rails in the position set, and must be released before the switch can be thrown.

From Golden to Field, 34 miles, there is an ascending grade eastward of 4½%, up which the train of eight passenger cars was taken by three engines (a ten-wheeler in front, one consolidation in the middle and another consolidation at the rear). Trains of 10 and 12 passenger cars are taken by four engines. One consolidation engine will take 5 or 6 freight cars up this grade. These engines have cylinders 20 × 26 ins., driving wheels 47 and 50 ins. diameter, and weigh about 100 tons, with tenders.

The scenery along the Rocky Mountain division of the Canadian Pacific Ry. is of the most wonderful and magnificent character, but space forbids any attempt to deal with this aspect of the line in a technical journal, beyond saying that it warrants all the descriptions and praise at the disposal of a literary general-passenger-agent, and surpasses all expectation. At Banff the railway company has a hotel, situated in the midst of grand mountain scenery and near hot sulphur springs, which attract both tourists and invalids. The summit point on the line is Stephen, 5,296 ft. above sea level, and 519 miles from Vancouver.

After all this splendor of mountain heights the passenger who looks out of the car in the early morning of the third day cannot but be surprised at the change of scenery, for here (in the neighborhood of Medicine Hat) is rolling prairie, with no signs of a mountain. This prairie land continues practically all the way to Winnipeg, broken only by occasional patches of timber country, while east of Brandon there are greater evidences of settlement and civilization. On the prairie divisions there is but little regard for appearance in the track work for maintenance of way, and on many of the sections the ballast is pretty well overgrown with weeds. The shallow cuts on this rolling prairie are protected from snow drifts by rows of saw slabs set on end, and by low earth banks made from earth obtained by flattening out the slopes of the cuts. Immense areas of the prairies are burned over, and several fires in the dry grass were started by sparks from the engine, but a fire guard of furrows is plowed along the boundary of the right of way. At Chater is the junction of the Great Northwest Central Ry., a small line with an imposing name, while at Portage la Prairie is the junction of the Manitoba & Northwestern Ry. Both of these lines, as well as the new Lake Dauphin Ry. (now under construction), are developing the territory north of the C. P. Ry.'s main line, and the C. P. Ry. has several colonization lines in that part of Manitoba lying south of its main line.

Eastward from Winnipeg the line runs almost north, along the Red River, to Selkirk, for Winnipeg lies at the base of a flat V in the alinement of the road. The route was originally laid out due west from Selkirk, which is at the mouth of the Red River (on Lake Winnipeg), and construction was commenced (the old roadbed being now a highway), but the famous land boom of Winnipeg resulted in diverting the line to that place, which is 20 miles from the lake and can only be reached by small vessels at high water. As there is a large traffic in whitefish from the lake, the C. P. Ry. later built a branch line to West Selkirk, opposite Selkirk. At Winnipeg are the divisional offices (Wm. Whyte, General Superintendent; D. A. Stewart, Engineer), and also extensive shops. These shops have to do all repairs to (and even practically rebuild) the 150 engines of the Western Division,and are in charge of Mr. W. Cross,Master Mechanic. Both diamond-top and straight smokestacks are used, the former (with low nozzle) where lignite is used and the latter where anthracite is used, as noted in a former paper of these "Notes" (Eng. News, Sept. 17, 1896). Single nozzles, 3⅞ to 4 ins. diameter, are used, and give better results with less back pressure than double nozzles. The Smith triple-expansion exhaust is being tried, but it is said that in fuel economy an engine with a deflecting fire-door (as used on the Grand Trunk Ry.) has taken the record from an engine with this exhaust, while an engine with low nozzle and diamond stack has taken the record from an engine with the Smith exhaust pipe and straight stack. In both cases these engines were run in competitive service.

The water used on this division is very bad for the tubes and fireboxes, the scale being deposited very rapidly. No cast-steel wheel centers are used, but wrought iron centers imported from Glasgow, Scotland, have made nearly a million miles, and are in perfectly good condition. A limit of ⅛-in. is allowed for the wear of tires before turning. The tools in these shops show the names of the Niles Tool Works,McKechnie & Bertram,of Dundas, Ont., and Craven Bros., of Manchester, Eng. The English tools are heavier, and it is claimed that the heavy tools, such as wheel lathes, are more substantial, and can be run to their full capacity with less vibration. Power is supplied by a Corliss engine built by Thomson & Williams (Stratford, Ont.), and externally fired tubular boilers. Several experiments have been made in utilizing old tubes, and fence posts made in this way are very satisfactory. Some of the wooden floors are being replaced by 3-in. cement floors on a foundation of cinders and foundry scale which has been left for a month to be walked over and tramped down by the men. Car repairs are largely done out of doors throughout the winter, the air being dry though cold. A reading room and library for the use of the employees, has been established at these shops.

The Dauphin Lake Ry., above referred to, is a colonization line of light construction, being built to develop the country west of Lake Winnipeg. It is, of course, aided by a government subsidy. From Arden, near Gladstone, a natural gravel ridge runs northwest, practically parallel with the line, and marks the limit of an ancient lake beach. Work on the railway was delayed by the wet season, which made grading in this prairie soil very difficult. The tracklaying was done partly by machine. Four locomotives, built by the Canadian Locomotive Works, of Kingston, Ont., and 50 box cars, built by the Crossen Car Works, Coburg, Ont., were delivered during the autumn. Mr. D. D. Mann, of Winnipeg, is at the back of the enterprise.

That part of the C. P. Ry. between Winnipeg and the Great Lakes is peculiar in that it crosses alternately rock, muskeg (marsh), and water, the country being rugged and broken, and affording no lead in the way of valleys or streams to be followed by the railway as in mountainous country. In excavation, dynamite had to be used for the rock work, as powder was not powerful enough to shatter the tough rock. It is difficult to maintain the grade, as the banks settle, leaving the cuts high. The heavy traffic is almost up to the limit of the operating capacity of a single track line in such a country, and the double-tracking is already under consideration. Several trestles on soft bottoms have been replaced by banks of cinders or sawdust. There are several large trestles which it is not considered advisable to rebuild, but as any failure would seriously interfere with operation, on account of the difficulty of building new structures in treacherous swamps and deep lakes, steps have been taken to render them as safe as possible. Extra piling is therefore driven, a new deck is built, and this deck is extended onto the bank and provided with heavy guard rails to catch any derailed car before it reaches the trestle. At least one trestle has fire protection by a 3-in. or 4-in. water pipe extending the length of the structure and provided with valves at intervals. To protect the structure from fire from the engine ashpans, a cheap method of covering the floor is being tried. Planks 1 × 6 ins. are laid on the ties between the rails and between the guard timbers and rails, covering the spaces (3¾ to 4½ ins.) between the ties, and on these is placed a layer of cinders or gravel, 2½ to 3 ins. deep. The ties used in renewals on this division are cut in the winter and put in during the spring, though it would be obviously better to allow them to season for a year. They would then be more durable, and lighter and cheaper to load and haul. Experiments are being made with ties of different kinds. The track is mainly of 72-lb. rails with six-bolt joints. Square rail joints are preferred to broken joints, except on bad track.

The division between the east end of Lake Superior and Montreal is extremely dusty and dirty. Some sections are thoroughly overgrown with weeds (and therefore free from dust), but are yet in fair condition of line and surface, but most of them are kept pretty well weeded, with the result that a dense cloud of dust rises behind the train, causing discomfort to the passengers and injury to the running gear of the rolling stock.

Montreal (Windsor St. station) was reached at

7:45 p. m., Aug. 8. The headhouse of this station is to be enlarged, to provide additional accommodation for the general offices of the company. A new station is to be built at the east end of the city, as described in Engineering News, Dec. 31, 1896.

Winnipeg, Manitoba.

This is the largest city of Canada, west of Ottawa, and is an important commercial and railway center. It is a divisional point on the Canadian Pacific Ry. main line. The headquarters of the Manitoba & Northwestern Ry. are here, and the Manitoba & Northern Pacific Ry. (part of the Northern Pacific R. R. system), which runs to St. Paul, Minn., has a terminal station and a fine hotel building. A line also runs north to Selkirk, on the Red River, near Lake Winnipeg, and a flat-bottomed stern-wheel steamer also makes irregular trips between Winnipeg and Selkirk, touching occasionally on the rapids, when the splintered condition of the stern-wheel shows the attempt of this marine wonder to walk on the bottom. The bumping over the rapids is a rather pleasant break to the monotony of the trip. The Hudson's Bay Ry. is projected to start from Winnipeg, but it does not seem probable that much energy will be expended on construction in spite of that expended on endeavors to secure subsidies.

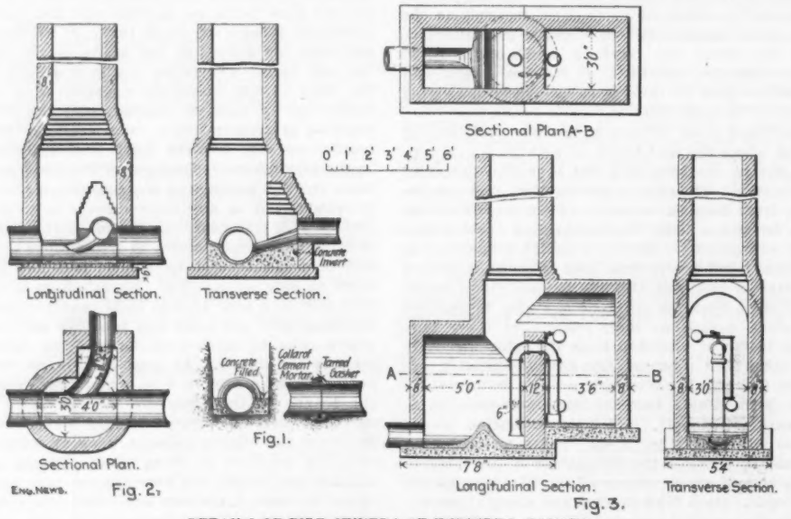
The city has a population of nearly 40,000, although only 20 years ago it had but 3,000. There are only 17 miles of paved streets, and most of the streets are in pretty bad condition. Round cedar blocks are used somewhat extensively; plank paving is used on some side streets, but is expensive; macadam is used successfully if the section of paving is long enough, as the ends become spoilt by the mud carried upon the road surface from the unimproved adjacent road, the wheels and mud pulling up the stones of the macadamized portion. Asphalt on concrete has been proposed, but has been delayed by troubles between the bidders and property owners as to who should have the contract. The city is built on a black earth, which a very little moisture transforms into a sticky, slimy, mud, so that in wet weather the unimproved streets are practically impassable, and in several cases houses have been destroyed by fire owing to the inability of the fire engines to reach them. Attempts have been made to prevent this by laying sand or gravel on the earth roadway, but this soon works in and is lost, leaving the road in its original bad condition. The new roads and street extensions are formed by ploughing up the prairie with a road grader, the mold board of which gives the proper shape to the road surface. For road repairs a triangular scraper is used, open at the narrow back, which cuts down knolls and fills ruts. The sidewalks are mainly of plank (with frequent evidences of neglect and decay), though on the main streets there are some good cement sidewalks, having 4 ins. of granolithic concrete surface on a 1-in. bed of rammed earth. Octagonal tiles of cement, laid on gravel, are used in some of the residence streets. Main St. was repaved with round cedar blocks this summer, the old paving having been in use 12 years, though it should have been renewed two years ago. This pavement has a 3-in. foundation of sand, one transverse layer of planks, one diagonal layer of planks, and then 6-in. cedar blocks of all sizes, dry grouted with gravel. This paving costs 73 cts. per sq. yd., while 9-in. macadam costs about 90 cts. per sq. yd. Ordinarily the cedar block paving lasts 6 or 7 years under moderate traffic, and then requires to be renewed. Broadway is being improved to form a boulevard, with turfed strips in the middle and at the sides, and two macadamized roadways made with a yellow limestone. The sewers discharge into the Red River, causing somewhat of a nuisance at times, and plans have been prepared for an intercepting sewer to discharge at some distance below the city. At present, however, the only work in this department is the building of a brick sewer and some small pipe sewers, the pipe for the latter being imported from the United States. The manholes and flush tanks and the method of laying pipe sewers are shown in the accompanying figures, prepared from blue prints kindly furnished by Mr. H. N. Ruttan, M. Am. Soc. C. E., City Engineer.

The water-works are owned by the Winnipeg Water Co., which pumps the supply direct from the Assiniboine River, and has a plant of National filters at the pumping station. The water is not very good, being more or less alkaline. No extensions are now being made to the distribution system, although it is not now sufficient to meet the needs of the city. The pipe is made in Montreal or imported from Scotland. The water rates are said to be high, and for several years past it has been proposed that the city should purchase the works. The company's charter, it is stated, has still about five years to run, and it is desirable that the expense of a new system should be kept down by its not covering parts of the old system that are good. The City Engineer was directed to make a report on the present value of the water-works plant, and the company was asked to give its estimate of the value. The City Engineer was also directed to give an estimate of the present value of the water-works, to be used as part of a new system, and in connection with an underground supply from artesian wells.

The utilization of water power and the transmission of power by electricity are subjects of present interest at Winnipeg, as it is proposed to transmit power from the falls at Keewatin, 120 miles east of this city. A dam has already been built, and it is said that water wheels are to be put in. Another and apparently more feasible project is to put a dam in the Assiniboine River, one mile above the city, utilizing a head of 20 ft. and developing 2,000 HP., at a cost not greater than that of the transmission line from Keewatin. This latter project has been favorably reported upon by Mr. H. N. Ruttan, City Engineer, with Mr. J. T. Fanning, M. Am. Soc. C. E., as consulting engineer, and the city will undertake to take sufficient power for the rental to be 3% on the capital. So far, however, it has been difficult to get capital, although several promoters have taken hold of the scheme at different times, but only with the idea of selling out. A dam has also been proposed on the Red River, below the city, to give improved navigation over the rapids already referred to, and this might also be utilized for water-power purposes.

There are several bridges over the two rivers, and the Osborne bridge has a new superstructure, designed by the City Engineer, and built by the Dominion Bridge Co. All the bridges have draw-spans, the government requiring this for all navigable streams, but they are rarely opened. The Osborne bridge has a concrete pivot pier, with an outer shell 3 ft. 6 ins. thick and cross-walls inside. The cost of this was $7.50 per cu. yd., as against $16 for stone masonry. The concrete is composed of 1 part cement to 7 parts sand and stone, layers of large stone being laid to economize in the quality of concrete, forming thus a rubble concrete. This concrete resisted the ice perfectly last winter. The bridge is designed to carry electric cars, but no tracks have yet been laid over it. A concrete pier is soon to be built for the Main St. bridge. The bridges are painted white.

The accompanying illustration shows some of the details of the pipe sewer work, taken from blue prints furnished by Mr. H. N. Ruttan, City Engineer. Fig. 1 shows the method of laying the pipe on a concrete bed and making the joints. Fig. 2 is a manhole; the concrete core for the invert is composed of 1 part of cement, 2 parts of clean, sharp sand and 5 parts of clean 2-in. broken stone; the surface of the invert is correctly formed and faced with a mixture of 1 part sand to 2 cement, 2 ins. thick. The 6-in. thickness of the footings is for manholes and flushtanks up to 10 ft. deep; for depths of 10 to 15 ft. the footings are 6 ins. thicker and wider; for depths of 15 to 20 ft. they are 12 ins. thicker and wider; for depths over 20 ft. special plans are prepared. Fig. 3 is a flushtank designed by Mr. Ruttan.




**DETAILS OF PIPE SEWERS AT WINNIPEG, CANADA.**
**H. N. Ruttan, City Engineer.**

Montreal.

This is the largest and most important city in Canada, having a population of 300,000, and is a great railway center, and the head of the steamer navigation on the St. Lawrence. Mount Royal, from which the city takes its name, may be ascended in carriages by a fine driving road, which winds its way up in the manner of a switchback railway, but there is also a cable incline, operated by the Montreal Park Incline Ry. This line is in two sections. The first section has an easy grade and is equipped with two cars, one at each end of a traction rope, while an endless cable is also provided for safety purposes. The cars resemble ordinary street cars. The second section has a very steep grade, and the seats are fitted horizontally on an inclined frame with two wheels at each end. Three ropes are used on this section.

The Montreal Water & Power Co., which supplies some small municipalities, recently built a concrete-lined reservoir on the mountain, and water was turned in a few days after completion. Extensive leakages occurred and the company claimed that this was due to defective concrete, but the contractor's engineer considered it to be the result of leaky and clogged valves, the leakage being too great to be assumed as coming through the concrete. The matter is to be investigated. About 4,200 barrels of cement were used on the work, and as the brand specified could not be obtained quickly enough, another brand was also used, by permission. This was evidently not of a uniform character and resulted in some defective concrete, but apparently not so seriously defective as to account for the leakage. There has also been considerable trouble with leakage from the old city reservoir on the mountain.

Very little money was spent last season in street or sewer work, the appropriations having been expended in purchasing land for widening streets. Trinidad asphalt is considered preferable to rock asphalt for street paving, as it is unaffected by heat or cold, and can be readily cut out and replaced at worn spots. Trinidad asphalt costs about $2.56 per sq. yd., while rock asphalt costs $3.86. Mr. P. St. George is City Surveyor, and has held this position for several years.

### Montreal Harbor Improvement.

One of the most interesting pieces of engineering work now in progress is the construction of the earthwork guard pier to form a large basin for shipping and to protect the water front from the winter ice shoves. This pier, as described and illustrated in Engineering News, May 2, 1891, is an earth embankment in deep water parallel with the shore, and extending down stream from a point near the north abutment of the Victoria Bridge. The bank is built of material dredged from the harbor, this material being deposited in tubs on a scow, so that it can be sorted and different kinds of material deposited on different parts of the bank. On the top of the bank is an enormous traveling derrick, having two great swinging booms, whose paths overlap, so that either boom can pick up a tub from either track and deposit it on any part of the slopes. When a scow arrives at the landing trestle at the bank, the tubs are hoisted up and placed on small four-wheel flat cars, the trains of cars being handled by two saddle-tank four-wheel locomotives. A train is then run to the great derrick, and the tubs are hoisted off, swung round to any desired point, and dumped. The river face of the slope is dressed with roughly sorted stone. The ice shoves do not hurt this much, merely scratching the surface,and a couple of men with picks can soon remedy all this. It is when the ice strikes a vertical face that it piles up and does its damage. An opening will be left between the bridge abutment and the upper end of the guard pier, as there is a popular cry for circulation of the water in the basin. There does not appear to be any real reason for this, especially, as the river and canal discharge into the upper end of the basin. Long piers for ocean steamers are to extend from the shore out into the basin, but work on these has not yet been commenced.

Dredging is in progress on the basin, all the work being done by dipper dredges, some of which were built by the Carriere & Laine Co., of Levis, Que. One great dredge has a bucket of 4¼ cu. yds. capacity, with heavy teeth keyed on, these teeth being of iron with points of tool steel welded on. The rim is 4 ins. thick, which is unusually heavy, and the side plates are about ⅝-in. thick. The bucket is carried on the end of an iron latticed boom, and operated by direct haul without blocks, the power being obtained by the gearing of the engines. This bucket digs a heavy shale or slaty rock. The spuds of the dredge are of Douglas fir, 36 ins. square, 60 ft. long, with wire rope passed through sheaves let into the timber, so that the spuds are pulled up or pushed down by power and then clamped. The stern spud has a crowbar point, and is worked by a steam cylinder.

Ladder dredges, or clamshell dredges, are not well suited to this locality, on account of the number and size of boulders to be dealt with, some being 12 to 15 ft. long. To remove the large boulders Mr. Kennedy, the engineer, designed a scow with a center well, over which is mounted a derrick carrying a pair of magnified ice tongs with a clear space of 14 ft. between the jaws. For ledge work, there is a drilling scow, with three drills mounted on the side. These drill 4½-in. holes, a smaller bar being used if the full-sized bar will not go down to the full depth. Each hole is charged and fired as soon as ready, without stopping the other drills. The explosive used is mainly 75% dynamite. No steam hose is used, but telescopic metal pipes instead. All the work in the harbor is done by the Harbor Commission, and about 500 men are employed during the working season. Mr. John Kennedy is Chief Engineer of the Commission.

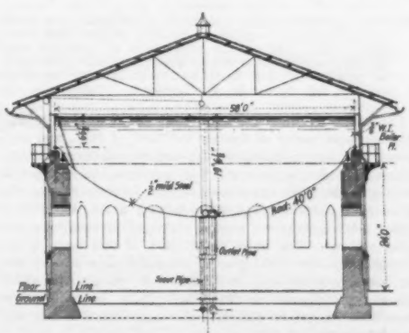
### Montreal to New York.

For the return trip to New York I selected the route by the new Adirondack & St. Lawrence Ry., over which the New York Central R. R. has through trains between Montreal and New York. These trains use the Canadian Pacific Ry.'s terminal station on Windsor St., and cross the St. Lawrence by the great Lachine cantilever bridge. The floor of this bridge has two sets of outside guard timbers, the first set being faced with iron. Near Valleyfield is a lifting drawbridge, with plate girders, operated by a derrick, or A-frame, spanning the track at the hinged end of the bridge.

The Adirondack line has stations of ornamental design, and all stations, tanks, section houses, etc., are painted bright yellow and black. The road was built rapidly and trestles were liberally used; many of these structures are now being filled in and the banks are being widened, with the result that the road is intolerably dusty in dry weather. Some of the trestle floors are very defective at the ends, the guard timbers not extending onto the banks, and holes showing between the bank and the floor. The iron bridges have solid trough floors, but no guard timbers are used on these. The track is laid with heavy steel rails, having suspended six-bolt joints, and 17 ties to a rail length. Split switches and spring-rail frogs, are used, together with iron slat surface cattleguards. Box rail braces are largely used, but do not seem to fit well, many being tilted up by having a wooden shim put under the heel. This may be due to their use on old ties, but they certainly rattle badly. The ballast is, of course, gravel and pebbles. Twisted ribbon wire fencing is used, with two vertical spacing bars in each panel,between the fence posts. In some sand cuts the sand is drifted level with the ties and nearly up to the rail heads, while some of the gravel cuts are badly washed, the gravel filling the ditches and covering the ties. These are the sort of places where good, economical results should attend an attempt to grow grass or bushes. Most of the locomotives were built by the Brooks Locomotive Works, of Dunkirk, N. Y., and they are conspicuous by their cabs, finished in natural wood, and with large windows. One of the powerful ten-wheel engines of this road was illustrated in Engineering News, June 18, 1896. I left Montreal at 7:30 a. m., Aug. 12, the train reaching Utica (where connection is made with the New York Central R. R.) at 3:50 p. m., and arriving at New York city, 466 miles, at 9:40 p. m.

## A WROUGHT-IRON WATER TANK WITH A CURVED STEEL BOTTOM.

The idea of using a curved bottom for a metal water tank has been conceived and carried out in India, as well as in western countries. We give herewith a cross-section of such a structure connected with the water supply of Ambala, India. The




**Section of Water Tank with Curved Bottom at Ambala, India.**

tank has a capacity of about 264,000 U. S. gallons, and its principal dimensions are given on the section. The following additional facts regarding the structure are condensed from a description in "Indian Engineering," to which we are indebted for all the information given:

The hoop girder from which the bottom is suspended rests on a steel double-headed rail all round, which acts to a certain extent as a rocker and bears on a 9-in. cast-steel bed-plate below. The cylindrical portion likewise rests on a steel double-headed rail, which is carried on pillars all round. The connecting curved steel plate acts as a spring and allows of independent expansion and contraction in the bottom and the vertical cylinder.

The tank, as described, is supported on two lines of rails on a masonry structure. The 7-in. inlet runs up the side of the tank and discharges in the top through an equilibrium ball valve. The discharge is taken from the center of the tank by two pipes.

The roof frame is composed of strong T-irons trussed together. The roof covering consists of corrugated iron supported on wooden purlins. The roof is double-lined with ¾-in. ceiling boards; one line of boards being fixed to the truss and the other on top of the purlins under the corrugated iron, leaving an ample air space between them.

The top of the structure is finished by an ornamental finial fitted with a lightning conductor. The tank is provided with a ladder inside and also with a gage to indicate the height of water. It is also provided with an overflow pipe.

## THE REPORT OF THE NEW YORK RAILROAD COMMISSION.

The Board of Railroad Commissioners of New York state has completed its report for 1896, and from advance sheets of the report we quote as follows:

Physically the railways are, in the main, in good condition. The standard of maintenance is high. Increasing attention is paid to minor details that contribute to the security and comfort of the traveling public. Some of the smaller lines have not been able to keep up with the trunk lines in the excellence of their maintenance, but what has been lacking in this respect has generally been made up by extreme caution in operation and the temporary strengthening of roadbed and structures until increased prosperity permits permanent betterments. The Board was compelled in only two instances during the year to direct either suspension of operations or the making of necessary repairs, and in both instances the repairs were promptly made in accordance with the recommendations of the Board's inspector.

The most important pending legislative suggestion is in connection with the abolition of grade crossings. With the enactment of such a grade-crossing law as has been recommended by the Board will be ushered a new era in railway construction which will be more enduring in its character, less liable to accident in the operation of the roads, permissive of even faster time than is now made by the Empire State Express, and more economical in maintenance.

The synopsis of the report made by the inspector of 6,263 miles of railways examined by him during the year, shows a generally satisfactory state of affairs, as to weight of rails, ties, joints, etc., but there is the somewhat singular suggestion that on six-bolt joints the two end bolts may have the nuts on the outside of the rail and the others on the inside. The blocking of frogs, etc., is largely neglected, and it is suggested that no great improvement in this respect is to be expected until New York follows the example of other states in passing legisation to make this work compulsory. Guard rails on bridges and at switches are also very frequently defective. The inspector has made special inquiry into the question of transition curves, and finds a general consensus of opinion to the effect that curves so laid out ride easier, cause less wear, and give a better distribution of the superelevation. Track forces have been found to be materially increased in most cases, but attention is called to the fact that it is false economy to reduce the force below the number of men required for necessary maintenance. Barbed wire fencing is disappearing, and with other wire fences there is a tendency to reduce the panel lengths.

At grade crossings there were 85 persons killed and 127 injured in 1896, being respectively 21 and 47 more than in 1895. The bill for the abolition of grade crossings (both of steam railways and of steam and electric railways), as proposed by the Board will be introduced again, and a bill for the use of gas or electricity for lighting all passenger cars is suggested. There were in all 678 persons killed and 1,607 injured as compared with 694 and 1,125 in 1895. An interesting table of accidents on street railways gives the following totals:

| | 1895. Killed. | 1895. Injured. | 1896. Killed. | 1896. Injured. |
|---|---|---|---|---|
| Lines operated, mech'l traction.. | 54 | 214 | 59 | 351 |
| Lines operated, horse traction... | 5 | 33 | 12 | 40 |
| Total ..... ..... ..... | 59 | 247 | 71 | 391 |

The most serious operating difficulty with which the Board has had to deal during the past year has been in connection with street surface railways, particularly upon lines where, in order to handle heavy Sunday traffic without sufficient car accommodations, the extremely dangerous practice of overcrowding has been permitted. The Board caused several investigations to be made, and it was found that not only was operation characterized by an utter disregard of a city ordinance regulating the number of passengers to be permitted upon a car, but also by non-observance of ordinary safety precautions and gross carelessness upon the part of employees. In one instance this

overcrowding was found to have been the chief factor in causing an accident which resulted in the killing of two passengers and the injury of several others, and it was learned that this overcrowding was a common practice, particularly on Sunday, on the cars of the company upon the line of which the above accident occurred. The car in question had a seating capacity for about 60 and could safely carry 20 to 25 additional; at the time of the accident there were 133 on board.

THE NEW ORLEANS DRAINAGE COMMISSION, on Dec. 31, opened bids for the construction of a canal and levees in 17th St., this being an extension of the present Melpomene outfall canal. The canal is to be unlined, about 35 ft. wide at the top and 11 ft. at the bottom, about 8 ft. deep and 6,400 ft. long. The dirt excavated will be used in forming levees, one on each side of the canal, as this is a high-level canal, emptying into Lake Ponchartrain by its connections. The bids for the work were published in our issue of Jan. 7. On Jan. 14 the Drainage Commission is expected to call for bids for the construction of pumping stations Nos. 2 and 7 and the construction of the Orleans relief and outfall canals to the lake.

RECENT DEVELOPMENTS IN THE IRON TRADE such as the rupture of the steel billet pool, the Carnegie-Rockefeller deal, etc., and their probable effect upon prices in the future are ably discussed in the "Iron Age," of Jan. 7, in a review of the Pittsburg iron trade in 1896. Concerning pig iron it says:

The extraordinary records being made at Duquesne portend what to expect in the future, and the announcement that the equipment of the two furnaces now in blast, and also of the two building, will be so improved that each stack will be capable of turning out 1,000 tons every 24 hours, simply means that other furnace interests must take steps to protect themselves and get into position to meet this competition. With the Carnegie-Rockefeller arrangement in operation and the Pittsburg, Bessemer & Lake Erie R. R. completed, by which ores will be brought from Conneaut to Duquesne for 45 cts. per ton, the production of Bessemer iron at a figure close to $7 is not only possible but probable. Railways must come down with freight charges, the ore producers must be contented with lower prices, and possibly labor will have to share in the impending leveling in values. With the completion of the two furnaces at Duquesne now under erection, Pittsburg will be in a position to turn out close to 3,000,000 tons of pig iron per year, a large share of the entire production of the country.

As for steel billets, the pool price of which was $20.25 in 1896, and the present price, in the absence of a pool, $15, it says that the new ore deal and the completion of the new railway "means $12 billets or less, and the underselling, if necessary, of their competitors in every part of the world."

A TRANS-MISSISSIPPI & INTERNATIONAL EXHIBITION is to be held at Omaha, Neb., from June to November, 1898. The plans are not yet decided upon, but about $300,000 will be expended in buildings and improvements upon the grounds. The arrangements are in the hands of an organization of which Mr. Gordon W. Wattles is President, and Mr. John A. Wakefield, Secretary.

A WISCONSIN SEMI-CENTENNIAL EXHIBITION is to be held at Milwaukee, Wis., next year. The greater part of the exhibits are to be arranged in a building segmental in plan, having a length of about 1,200 ft. The terraced roof of this structure will support promenades and so-called hanging gardens. The site will be on the lake shore, with connections from the top of the main building to the top of the cliffs. The general plans have been prepared by two architects, Mr. W. H. Manning, of Boston, Mass., and Mr. A. C. Clas, of Milwaukee. As proposed, there will be 87,500 sq. ft. each for the Transportation and Electrical departments, 50,625 sq. ft. for Minerals and Forestry, 102,375 sq. ft. for Liberal Arts, 71,250 sq. ft. for Agriculture, 21,875 sq. ft. for Horticulture, and 10,000 sq. ft. for Fisheries.

THE STEAMSHIP PASSENGERS landing at the Port of New York in 1896, says Landing Agent W. C. Moore, amounted to 99,223 cabin, and 252,350 steerage passengers. These came on 822 trips made by vessels of 21 lines and on 30 trips made by miscellaneous steamers. The North German Lloyd Company brought 38,034 steerage passengers from Bremen, and 16,146 from Mediterranean ports. This heads the list, though the Hamburg-American Line brought 32,280 steerage passengers from Hamburg, and 3,581 from the Mediterranean. The Cunard and the American Lines landed over one-third of all the cabin passengers arriving, or 17,999 and 16,859 respectively. The Hamburg-American landed 12,173; the North German Lloyd, 10,921 from Bremen and 2,634 from the Mediterranean ports, and the White Star Line, 11,607.

THE REGULATION OF THE HEIGHT OF BUILDings in New York was reported upon by a special committee at the annual meeting of the New York Board of Trade and Transportation on Jan. 13. This committee, after investigating the subject for some weeks, recommends that the law should forbid the erection of buildings in New York more than 150 to 200 ft. in height. The committee believes that the law should regulate this height in the interest of the whole community and submits the following as some of the important problems involved: Fire; effect upon general health; water supply and sewerage; legal rights of individuals as against their neighbors; the effect of high buildings upon neighboring real estate, and the general effect upon values of real estate of any law uniformly limiting the height of buildings; architectural and engineering features involved in foundations and in the permanency of materials; the effect of deep foundations upon adjoining structures. The Philadelphia Bureau of Building Inspection is also discussing the problem of high buildings, and Chief Wm. C. Haddock suggests a limit of 1½ times the width of the street. This would permit a building 170 ft. high on Broad St. and 150 ft. high on Market St., and a narrow street would then receive the same benefit from light and air as a broader one.

AN ENGLISH-PACIFIC CABLE agreement is reported as having been signed in London, on Jan. 6, by the representatives of the British, Canadian and Australian governments. The agreement is not yet made public, but is understood to favor the laying of a cable at the earliest possible moment between Vancouver and Australia and touching only British possessions. The estimated cost of the cable is $10,000,000.

CONTRACTS FOR TWO JAPANESE CRUISERS were signed on Dec. 31 with the Union Iron Works, of San Francisco, and Cramp's Shipyard, of Philadelphia, by the Japanese minister at Washington. Each ship is to have a displacement of 4,760 tons, a length over all of 374 ft., beam of 48 ft. and a draft of 17 ft. 9 ins. The contract speed is 22½ knots under forced draft, and the two vessels are to cost $3,000,000 and they are to be finished in two years. Their batteries will consist of two 8-in. guns, ten 12-c. m. guns, twelve 12-pdrs. and six 2½-pdrs; there will also be five torpedo tubes. A similar contract has been given to an English ship-building firm, with the view, it is claimed, of testing the relative merits of the ship builders of the two countries, and upon the decision is said to depend future contracts from Japan.

THE REFITTING OF THE OLD MONITORS as harbor defence vessels is suggested. There are 13 of these single-turreted monitors on the navy list, built in 1862 and rating from 1,875 to 2,100 tons' displacement. They have single screws operated by grasshopper engines of 340 I. HP. and have a speed of only 5 to 7 knots per hour. They are now armed with two 15-in. old fashioned smooth-bore guns on each vessel, with no secondary battery, and they are protected by 5-in. side armor and 10 to 11-in. armor on the turrets. Eight of these monitors are at League Island, and the rest are scattered along the coast for the use of the naval militia, except one, the "Camanche," which is at the Mare Island Navy Yard, in California. It is now suggested that these vessels could be made very serviceable for harbor defence by removing the turrets and fitting them each with two 8-in. modern guns mounted on disappearing carriages operated by compressed air. Their very low freeboard would afford but a small mark to the enemy, and their light draft, 11½ to 13 ft., would make them especially useful in shallow waters, where the heavier ships could not reach them. The six double turreted monitors are now all fitted with modern guns, of from 10 to 12-in. caliber.

## BOOK REVIEWS.

POWER LOCOMOTION ON THE HIGHWAY.—A guide to the literature relating to traction engines and steam road rollers, and to the propulsion of common road carriages and velocipedes by steam and other mechanical power. With a brief historical sketch. By Rhys Jenkins, M. I. Mech. E. London. 12mo.; pp. 64. 2s. 6d.

The historical sketch begins with the somewhat mythical steam-jet motor of Father Verbiest, of 1665, and then passes to Cugnot, Murdock, Symington and Oliver Evans. Compressed air, as a motor for carriages, is credited to Medhurst, in 1799, and an American, Davenport, was the pioneer in electric propulsion, having made, in 1835, a model electro-magnetic engine arranged to run on a circular railway. The most useful part of this book is the bibliography, the catalogue of scientific papers read and the index to periodical literature of all nations, in which references are made to the subject here treated. While these lists cannot be complete the compilation is interesting and useful.

A PRACTICAL TREATISE ON THE "OTTO" CYCLE GAS ENGINE. By William Norris, M. I. Mech. E. With 207 illustrations. Longmans, Green & Co., London, New York and Bombay. 1896. 8vo.; pp. 260.

This work is intended to furnish practical data, based on results of experience obtained by the leading makers of gas engines which work on the four-stroke cycle of Beau de Rochas and Otto. Only modern gas engines are considered. The various parts of the mechanism of the engines, self-starters, and other accessories, are illustrated and described in detail. The general arrangement, working and testing of gas engines are dealt with; and the observations, calculations and results of some elaborate tests are recorded. The author seems to be a master of his subject, and the work cannot fail to be of value to engineers and others interested in gas engines. It deals much less in theory and more with mechanical details than Donkin's work, the second edition of which recently appeared, and it should be very useful as a supplement to that admirable treatise.

TABLES SHOWING LOSS OF HEAD DUE TO FRICTION OF WATER IN PIPES.—By Edmund B. Weston, M. Am. Soc. C. E., M. Inst. C. E. New York: D. Van Nostrand Co. 12mo.; flexible covers; pp. 170; $1.

We are pleased to announce the publication of these valuable tables in a handy pocket form, and that they can now be obtained by any one who desires them. They originally appeared as appendices to the annual reports of the City Engineer of Providence, R. I., in 1888 and 1890, and in 1892 were reprinted, by permission, by the Massachusetts Institute of Technology, for the use of its students of civil engineering. In their earlier form they were rather perishable, owing to their having paper covers only, and they were too large for the greatest convenience.

The tables give, for different sizes of pipe, the mean velocity of water in feet per second; the head required to produce this velocity; the discharge in U. S. gallons per minute; the loss of head in feet due to friction, per 100 ft.; the discharge in U. S. gallons per 24 hours; and the loss of head in feet due to the orifice of influx, all for a wide range of velocities.

The first table is for pipes having very smooth interiors, similar to lead and brass, for nine sizes ranging from ½ to 3 ins. in diameter. The second table is for pipes having interiors similar to new cast iron pipes, of sizes from 4 to 60 ins. in diameter. The first table is based on a formula devised by Mr. Weston, and the second on the formula of Darcy, each after the study of a large number of experiments. Small supplementary tables, and instructions in the text, are given for the extension of the tables beyond their actual limits.

The tables are of great value in designing pipe systems, especially the distribution systems, for town water-works and service and distributing pipes for buildings. The matter explaining the tables is ample, and the tables are printed in large, clear type, making both a pleasing page and easy reference.

PRINCIPLES OF MECHANISM.—A Treatise on the Modification of Motion by Means of the Elementary Continuations of Mechanism or of the Parts of Machines. For use in College Classes, by Mechanical Engineers, etc. By Stillman W. Robinson, C. E., D. Sc., M. Am. Soc. M. E., etc.; Engineer and Expert for the Wire Grip Fastening Co. New York: John Wiley & Sons; London: Chapman, Hall & Co., Ltd. 8vo.; cloth; pp. 230; 353 figures; $3.

The author of this work was for many years Professor of Mechanical Engineering in the Ohio State University at Columbus, O., and has been a frequent contributor to the proceedings of technical societies. He has recently retired from teaching to devote himself to business pursuits in connection with the Wire Grip Fastening Co. and the Grip Machinery Co., and to develop the use of certain mechanisms of his invention. His investigations into the theoretical principles of mechanism seems thus to have led to important commercial results; a fact which may encourage some college students to regard with more respect the study of the theory of mechanism, to which study, difficult as it appears to them, they are apt to devote as little time as the rules allow. Such students may also be grateful to Prof. Robinson for having published this work, in which many of the difficulties of the subject are made less formidable than they are in the older works. In method of treatment, clearness of illustration, and excellence of typography and illustrations, we think the present volume is superior to any on the subject which has come under our notice. The scope of the work is shown by the following extracts from the preface:

This work aims to treat the whole subject of mechanism in such systematic and comprehensive way that by its aid any machine, however elaborate, may be analyzed into its elementary combinations, and the character of their motions determined.

In the classification the system of Prof. Robert Willis has been followed in the main, as serving best the present purpose; and largely his names and terms as well.

The work contains the substance of lectures given in the author's classes during the past 27 years, with such additions and amplifications as might come by reason not only of a somewhat extended study of the subject, but as brought out in connection with an aptitude for the thinking out of inventions involving more or less novel and varied forms and combinations.

Besides Willis, some of the authors whose works have been referred to with profit may be named: Prof. C. W. MacCord, Geo. B. Grant, J. W. M. Rankine, F. Reuleaux, J. B. Belanger, Ch. Laboulaye.

Some of the topics to which special attention is invited embrace either entirely new solutions of important questions, or previously unpublished discussions and extension of inquiry concerning them.

The treatment has been mainly by graphics instead of by analysis, for three reasons: 1st, because the draftman's outfit is usually at hand when mechanism problems arise; 2d, because these problems usually do not require the precision of analysis, the graphic method serving for problematic work as well as for delineation; 3d, because analysis, though possible in a few of the simpler problems, becomes difficult and often impossible with very slight variation of conditions, while by the graphic method all cases, whether of simple or complex statement, are solved with nearly equal facility. Hence analysis has been employed here only to establish principles the application of which subsequently might be made by the graphic method.